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Including SOUTHERN AVIATION and AERONAUTICS

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Are Aircraft Carriers Doomed

The Lexington pushes its way through a smoke screen. An unusual view of this great carrier.

by

ANDREW R. BOONE

ADVOCATES of a smaller American navy—both across the Atlantic and the Pacific—recently have made thinly-veiled proposals that aircraft carriers be abolished.

So-called friends of the navy within the United States propose that flight-deck cruisers and battleships, carrying 10 to 20 planes each, replace the mighty carriers, each of which transports to the scene of action six dozen fighters, scouts and bombers.

At one stroke these people would abolish the mighty air power Uncle Sam's navy has built up and rob the United States of the most powerful naval defense yet created.

From both England and Japan have come suggestions and propaganda calling for their abolition. British experts term them "obsolete and unfit for modern warfare," while Japan, particularly vulnerable to airplane attack, calls the carriers "weapons of aggression"—at a time when the naval limitations conference, scheduled to sit in Washington next year, is only a few months distant.

A few years ago both England and Japan entered into enthusiastic programs for building carriers as modern arms of their navies. America built with them, and although today we have only three carriers, our naval air force, consisting of some 400 airplanes capable of raining destruction on far-flung communities, not only has broadened the scope of American naval action, but also outstrips all other aerial forces in concentrated power and skill.

Critics have forecast wholesale destruction of American cities in case of war by gigantic fleets of foreign planes. The need for carriers was never more acute. Major Gen. James E. Fechet, former chief of the Army Air Corps, says we must have carriers for these vital purposes:

1. Off-shore patrol against raids on the Panama Canal, the base in the Hawaiian Islands and other important vulnerable positions.
2. Patrol of the Caribbean Sea against establishment of enemy forces.
3. Patrol of trade routes and escort of convoys.
4. Operation against enemy trade and lines of communication.
5. Seizure of advanced bases.
6. Operation with the battle force in any theater of war for protection, for scouting, patrol, reservicing of cruiser and battleship planes.

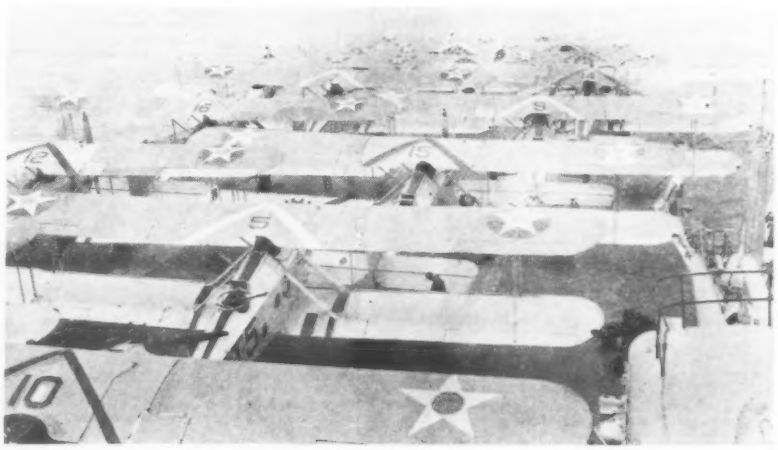
Some critics pointedly remark that an enemy raider could destroy our giant, 180,000-horsepower carriers *Lexington* and *Saratoga* in a single, brief engagement; to say nothing of the older and slower Langley.

To which naval flyers reply that the *Lexington* and *Saratoga*, and (when they join the fleet in a few months) the new *Ranger* (to be commissioned in May, 1934) the *Enterprise* and *Yorktown* (to be commissioned in 1937) not only can outspeed any known surface vessels, but also will be able to loose more than 400 defensive planes as well as defend themselves by anti-aircraft and other weapons the secrets of which are closely guarded.

The threat of the carriers against an enemy constitute a powerful American naval defense. The *Lexington* could start at dawn on Monday, say, on a 40-mile-an-hour dash toward some objective 1,200 miles distant, and on Tuesday morning, as the sun peeped over the edge of the world, her 72 planes would spread consternation and bombs over the enemy.

Twice the distance a battleship could cover at forced draft!

"The aircraft carrier," as Waldo Drake, the naval expert, points out, "is the only weapon by which continued



A flock of Uncle Sam's naval warbirds massed on the fore-deck of the Saratoga.

for Service in the Next War?

air operations can be carried on offshore.

"They are the only vessels that can successfully launch their planes and take them safely aboard even in boisterous weather."

The smaller scouting and observation planes can be catapulted from cruisers and battleships, but cannot be taken aboard during an engagement, when all guns may be firing, or in heavy weather.

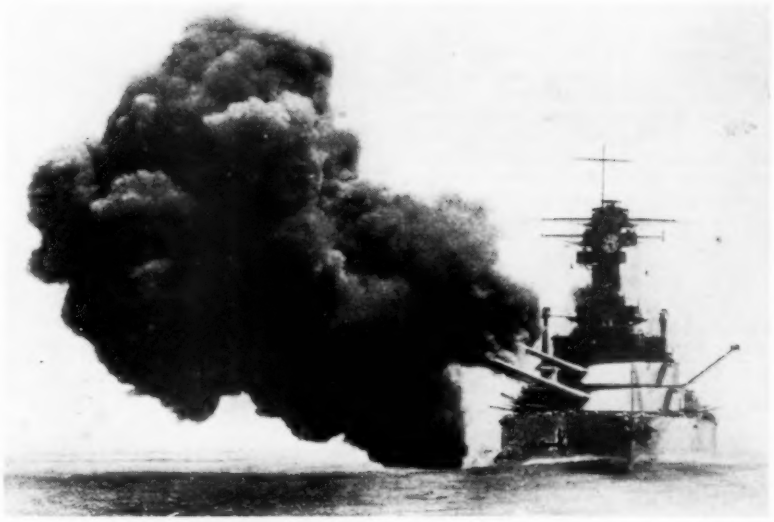
"An outstanding value of the carrier," Mr. Drake says further, "is that it can carry a great number of heavy bombing and torpedo planes, with weapons of great destructive power to menace any war craft afloat. Launching of such heavy planes by catapult is impracticable. "High mobility of the aircraft carrier—700 to 800 miles per day even in heavy weather, plus an additional several hundred miles' radius by its squadrons—is unequaled by any other type of surface craft carrying airplanes.

"Long-range patrol boats are powerful weapons, but they must return to fixed land bases, which, being stationary, are much easier to locate and destroy than highly mobile carriers.

"Aircraft carriers in war would be many miles distant from the battle line, but if in thick weather a carrier might blunder into range of enemy capital ships the poor visibility and her high speed would favor the carrier in escaping.

"Damage to the flight deck of a carrier would not necessarily result in loss of her planes, because if aloft, they could alight on the decks of accompanying carriers.

"The best defense against carrier-based aircraft is other carrier planes, so that a carrier's own squadrons would afford powerful aid against enemy bombing attacks."



Tests show that the terrific shaking caused by a broadside quickly destroyed planes on the catapults of a battleship. This does not occur with a carrier and, further, the carrier can pick up planes from the sea while a battleship cannot, at least when ploughing through the seas.

While fighting is a primary function of the fleet in wartime, her planes must perform many duties. What, in fact, are the duties of the many planes based on the carriers? Do they justify the creation and operation of these vessels?

Remember, there are three classes of planes on the carriers: scouts, fighters and bombers. To render fullest service, the scout must be able to penetrate the enemy screen and radio all available information to the commander-in-chief. The scouting pilot is an "aerial eye," capable of seeing all, hearing all and telling nothing—to the enemy. He must be able to get away quickly, climb high and speed to his destination. For that reason, scouts are based on the carriers, from whose decks they can rise in any weather.

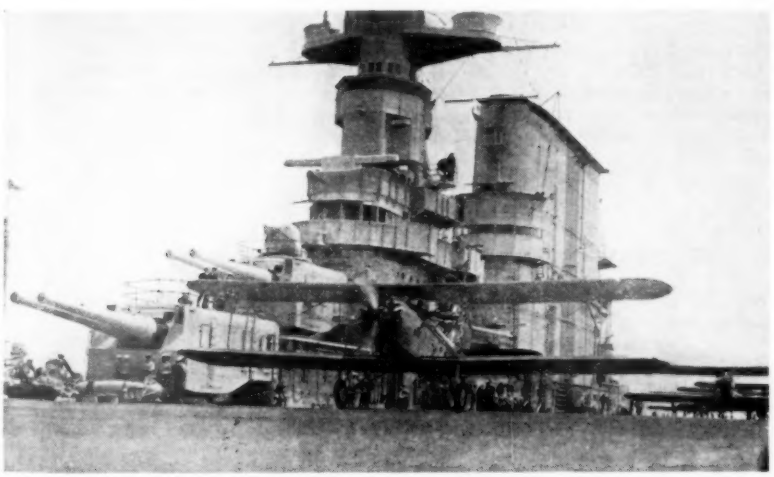
Far over the horizon an enemy commander sends his bombers into the air. Is he lucky enough not to be seen? Probably not. Four miles up, hidden in the sun, a lone scout—one of 50 on the carriers—witnesses the take-off. The radio buzzes. Surface ships form into lines, ready for the attack.

The white flag rises alongside the "island" on *Saratoga* and *Lexington*, the huge superstructure containing command posts. "Order out the fighters," it says. Motors roar, grim pilots signal ready, enlisted men remove the chocks and away they dash.

Each tiny plane, while seemingly starting from a standstill, begins to move along the deck with an initial *air speed* of 30 miles an hour or more, for the carrier during take-offs steams dead into the wind at speeds of 15 to 20 knots. Add to this the wind velocity, and you get air speeds.

There is nothing haphazard in this procedure. Fighters immediately form into squadrons, climb to put themselves above the unsuspecting enemy, test their machine guns—and soon engage that enemy in a fight to the death, beating it down and, of far more importance, preventing it from reaching our own ships.

Such a sensational air battle would not end here. We have hardly begun. Now come the bombers, heavy loads of lethal power snuggled to their bellies. These are great single-engined ships whose wings may be "clipped" to permit larger numbers to be stored in the enormous bellies of the carriers. They follow the scouts into the air and soon



She's off! A bomber taking off from the long deck of the Saratoga. Note the off side location of the carrier's superstructure.

are winging across the enemy's battle line.

Carrier planes make possible, also, naval engagements wherein fleets are hidden from each other across the horizon. Battleship planes "spot" the gunfire—but they go up only after carrier planes have cleared the air! Fighters not only protect the observation planes, but also protect the carriers, on whose expansive decks they settle again when danger no longer threatens.

The carriers send their broods into the air, then remain at a safe distance behind the battle line. In a remarkably prophetic picture published some time ago, you can see the *Langley*, oldest of the carriers, swinging away from the battle line after she has discharged her bombers, to take up her position over the horizon. The picture was taken when an "enemy" fleet made known its presence to the Battle Fleet during tactical maneuvers off Los Angeles.

"The navy's aerial development has taken place almost entirely since the World War," a high naval officer told me, "and without the advantage other nations gained by having observed their own planes in extensive war operations. The British Grand Fleet already had equipped itself with aircraft carriers. We confined our efforts to anti-submarine activities in acceptance of the interallied policy, and have re-designed nearly all naval aircraft to meet our own peculiar conditions.

"All navy aircraft must be relatively small and yet meet several requirements; must have high flying speeds and low landing speeds, and, above all, possess great strength to withstand catapulting, quick stopping on carriers and buffeting by the seas."

While Uncle Sam sends his second line of defense—air power—to sea on three floating islands, one of which is now woefully obsolete and the others exceed any others in range and speed, England boasts the *Argus, Eagle, Furious, Courageous, Hermes* and *Glorious.* Japan pins her faith on the *Kaga, Akagi, Hosho* and *Ryujo.*

When the *Ranger, Enterprise* and *Yorktown* join the fleet, we will have built up approximately to the limits of the London Naval Treaty, 135,000 tons —but not beyond.

There have been many criticisms leveled at the employment of aircraft carriers on the score that they are defenseless against the attacks of enemy bombers unless an overwhelming number of fighters are carried—so great a number that they would limit the number of bombers convoyed. This is yet to be proved.

Do we need aircraft carriers? Bear this one point in mind: in sea war games conducted by various navies, victory always has gone to the side with superior air power! In our sea-going flying fields lies a large measure of our naval strength—a strength making for world peace—which we will retain unless influences now hard at work doom the carriers.

END

Bureau to Make Flying Safer on Airlines

A transport plane on a scheduled airline flying through a gap in the pyramiding cumulus clouds, a beautiful and impressive sight.

FLYING on the airlines in the United States is going to be as safe as riding in the old-time horse and buggy, if the Department of Commerce has its way. New regulations governing scheduled interstate air transportation have just been enacted which are designed to cut accidents to a minimum.

First of all, the route that an airline is going to follow must be approved by the Bureau of Air Commerce. There must be intermediate fields at not more than fifty miles apart and the airway must be adequately lighted if flying is to be done at night. There will be no chance of a pilot taking off and barging into dirty weather unawares. Weather reporting systems are required to be located at terminals and along the route to keep the airmen informed of what to expect ahead.

Better airplanes are also demanded by the new rules. But that doesn't mean that some brand-new job that has just been licensed can be taken out to haul passengers. Aircraft of a new type or construction must have had at least 100 hours of proving test, including 10 hours of night operation in the hands of an airline operator before human cargo can be carried. And if any major changes are made in an approved type, 50 hours of test flying must be logged before it can be put into passenger operation.

And don't worry about climbing so high that you won't get enough oxygen. That has happened on some of the lines in South America. Passengers have gasped for breath like a goldfish panting on a parlor rug and some have passed out. But in this country, with the new high-speed airliners designed to climb up into the high, thin air three miles or more above the earth, Uncle Sam has issued specific instructions for the comfort and safety of passengers.

(Concluded on page 257)

The Death of Captain Gray

by CARL B. OGILVIE

The thrilling and gripping story of a fatal attempt at attaining the stratosphere by an American army officer. The author supplements his story by abstracts from this officer's diary.

SKY ordinary deep blue—sun very bright—sand all gone. Those words, written 8 miles above the earth, marked the tragic end of a gallant Air Corps officer. The handwriting is shaky and trails off at the last as his life fast ebbed away. A few minutes later, the flyer slumped to the bottom of the basket of his balloon and lost consciousness.

Thus ended the pioneering work in stratospheric flying done by Captain Hawthorne Gray. He was the first of the balloonists to penetrate to any extent the layer of air above the atmosphere and the lessons learned from his flights paved the way for the stratospheric pilots of the present day.

Captain Gray left a brief account of his last ride in the form of a log. Terse statements, jotted down hurriedly as he went about the task of reading his instruments and controlling the balloon, form a dramatic account of that fatal flight. This log has been presented by Captain Gray's widow to Paul Garber, curator of aeronautics for the National Museum. Not long ago, I had the privilege of examining it.

Grease marks from the Captain's gloves are still on it. The entries are made in pencil, in a firm, bold hand at first, but as the rarified air began to affect the airman, the writing became more and more difficult to read.

Gray had spent months of planning for the flight, which took place one cold November afternoon in 1927. He wished to study atmospheric conditions at high altitudes and to ascertain the effects of rarified air on the human body. It was thought that a person could not live in the open above 45,000 feet even when supplied with oxygen, because the atmospheric pressure in the lungs would be too low to sustain life. We know now that this is true, and so hermetically sealed gondolas are used. But at that time it was just a theory and Gray wanted to put it to the test—a brave venture, indeed.

Gray had previously ascended to 42,000 feet and had had to bail out with a parachute on the way down when the rate of descent became dangerously fast. Therefore, every possible precaution was taken to prevent accident. Every piece of equipment was carefully selected, tested and retested, to insure against failure at a critical moment.

Prior to the flight, numerous tests were conducted on animals and insects to determine the point at which life could not exist due to lack of atmospheric pressure. A rat was placed in a bell-jar and given a "flight" following as closely as possible the air density curve that Gray would encounter.

Captain Hawthorne Gray who died in a valiant attempt at establishing a new stratospheric record.

To determine how long the oxygen supply would last, Gray carefully measured the amount of air that he breathed and used this to compute the time allowed for the flight. It looked like no detail had been overlooked.

Gray was confident as he told his wife good-bye and climbed into the wicker basket of the balloon. The huge 80,000-cubic foot silver bag glinted in the afternoon sunshine and tugged gently in the grasp of the ground crew. Gray shook hands with the commanding officer of Scott Field, adjusted his helmet and gave the command, "Up ship!"

The crew let go and the bag floated quickly upward.

Airplanes circled around it, acting as an escort. They were able to keep the balloon in view for about half an hour, when it disappeared into the clouds and Captain Gray disappeared not to be seen again until a small boy climbed a tree near Sparta, Tennessee, and found his lifeless body in basket of the balloon, which had come to rest in the branches.

Let us look at the log and see what Gray was experiencing. The first entry is a brief *Scott* 2:23 51 meaning that he left Scott Field, Belleville, Illinois, at 2:23 p.m. Temperature, 51 degrees Centigrade.

Then there follows, 10,600 2:35, 24, *KMOX Kashmiri 27 37, Sympathy, 2 bags sand, R.C. 300 to 500.* He had reached 10,600 feet altitude at 2:35 where he encountered a temperature of 24 degrees. He tuned in with his radio receiving set on station KMOX (St. Louis, Mo.) and listened to the "Kasmiri Song" and "Sympathy". Just what the two figures mean is not definitely known but is thought to be the dial setting of the radio. He emptied two bags of sand in order to go higher and the rate of climb was 300 to 500 feet per minute.

Next comes the entry, *KSD, symptoms of rickets, 91, over Okaw, E of Mascoutah.* He tuned in on station KSD. He began to feel symptoms of rickets, which is a condition of shakiness and fever caused by want of oxygen. "91" is probably a radio dial reading. He was now over Okawville and started taking oxygen.

The following line of the log carries, *Bar No. 11 turns at 12,000 ft. Drop extra handl. rope 2:10 p.m.* The dual traverse lever of his barograph marked No. 11 changed its movement after indicating 12,000 feet altitude. At 2:10 p.m. he dropped an extra handling rope as ballast.

There follows an entry on radio reception. Then: *15,000, left glass foggy, 2:50 p.m., Red School House, heat 4V gogl part clear, 16,500.* At an altitude of 15,000 feet the left lens in his goggles became foggy due to condensation of body moisture, so he turned on a current of 4 volts through a heating device which partly cleared his vision by the time he had risen to 16,500 feet. Meanwhile, at 2:50 p.m. he heard "The Little Red School House" on the radio.

The next entry indicated that at 19,000 feet the temperature was zero and that he was listening to a saxaphone solo. Then: *23,000 3:10, snow, gloves, -8°.* At an altitude of 23,000 feet, reached at 3:10, it was snowing. He put on his gloves. The temperature was 8 below zero.

His next entry, at 24,000 feet, indicated that he was in the midst of a snowstorm, which was followed by notes on temperature and radio.

Then at 30,000 feet comes the notation of an occurrence that spelled the tragic end of Captain Gray: *Ice, sun, clock frozen.* He now had nothing to determine the passage of time, nothing to tell him how much longer the life-giving oxygen would last. From now on no time is mentioned, but the barograph, in its little box unseen by the aviator, continues to tell the story of the time of day and the height he reached. The other notes indicate that ice was forming on the balloon in spite of the sun.

The next entry deals with radio and then comes, *34,000 cyl off broke anten-*

na, no more music. At an altitude of 34,000 feet he dropped over an empty cylinder of oxygen which in falling broke away his radio antenna, thus he got no more music.

Then comes, *-40, too much heat, 2V, 36,000, -32°, getting warmer.* At 36,000 feet the temperature was 40 degrees below zero. The current used for heating his goggles was too strong so he reduced it to 2 volts. He was now entering the stratosphere, where it is warmer. Captain Gray found the temperature had risen to 32 below zero.

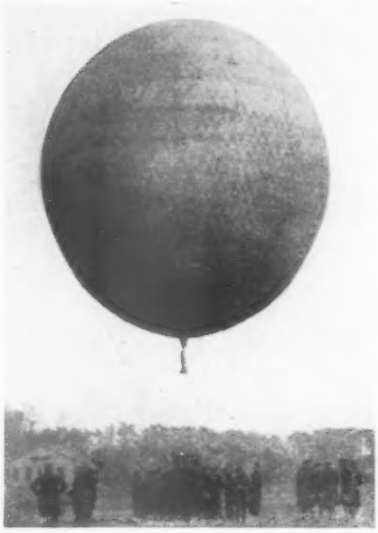
The handwriting becomes very shaky now. Gray is having difficulty in making his entries. There is a strange notation, *Hair pulling out belly, vaccum in mouth, 39,000 feet, -28°.*

This entry shows that his senses are becoming muddled. He wrote "hair" when he evidently meant "air". He observed that the lack of air density was altering the shape of the balloon by pulling out the lower section. "Vaccum in mouth" may mean either altered condition of the balloon envelope or personal discomfort in breathing. He has climbed to 39,000 feet and the stratosphere was becoming warmer, 28 below zero.

Captain Gray's strength is now failing fast. He has difficulty in keeping on his feet and in holding the pencil to write. He managed to scrawl one more notation on his log—that final brief message: *Sky ordinary deep blue—sun very bright—sand all gone—40,000.* As one ascends and gets away from the earth-haze and dusty air, the color of the sky deepens. Sometimes stars can be seen. Captain Gray noted the color of the sky and the brightness of the sun. He had emptied all of his ballast and was 40,000 feet high.

While this was the last entry made by Gray, the barograph still carried on. The curves show that the balloon was now behaving as one usually does when no more ballast is dropped—"oscillating," or pumping up and down.

It is practically certain that Gray was still alive, because immediately after reaching the maximum altitude and just as the balloon started down to begin another oscillation, it was valved.



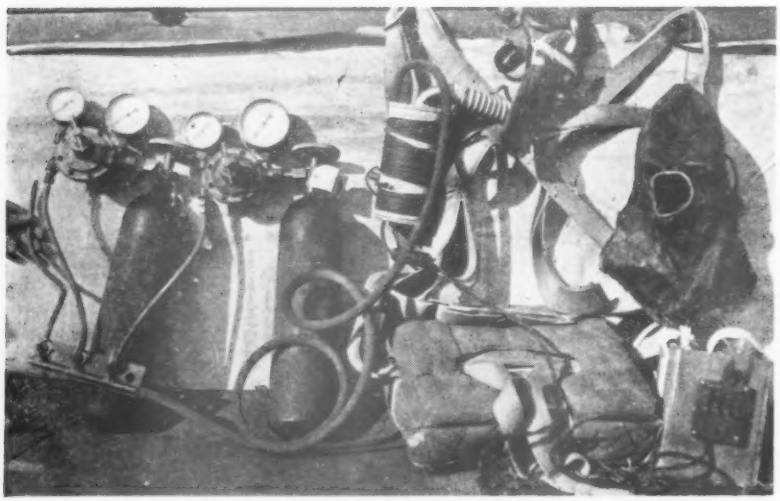
The balloon ready for making the ascent in which Capt. Gray lost his life.

Gray was probably lying on the floor of the basket but still had strength enough to reach up and pull the valve cord.

The time was getting short. Not much oxygen was left and Captain Gray did not have much longer to live. We know this by the time registered on the barograph, which, according to Gray's advance calculations, would be near the exhaustion of his supply.

At 4:38 he was out of oxygen. The barograph curve now becomes smooth and steady. Captain Gray is unconscious and the big bag is settling slowly towards the earth. At 5:20 p.m. it came to rest in a tree with the valiant man who had given his life to the cause of aviation still in his basket with his precious sealed instruments beside him.

END



Equipment used by Captain Gray on his flight of Nov. 4, 1927. Note the tube cut and the cock turned off, showing how he released one of the cylinders.

Airplane Benefits Hearing

A REVERSAL of deep-sea diving practice is being employed for the relief of deafness through the combined efforts of various aircraft pilots who provide charter service in Glendale, Calif., and Dr. W. I. Schuster, a Hollywood chiropractor. The method of treatment gives indication of highly successful results.

The deep-sea diver works under a heavy water pressure on his body. In coming to the surface, he rises a short distance, then remains at that depth until his body has opportunity to adjust itself to the pressure, then he rises again and stops for another readjustment and so on, until the surface is reached.

In the treatment for deafness, as worked out by Dr. Schuster, he administers a vibratory massage around the ears before the patient gets into the airplane. This softens all of the muscles and promotes the flow of blood. Then the patient is taken aloft—sometimes as high as 10,000 feet.

The pilot cruises around until the patient's ears are adjusted to the pressure and then a swift descent is made for a couple of thousand feet where the airplane is again leveled off with more cruising and more adjustment to pressure. This plan is operated at intervals all the way down to the ground.

America Leads in Commercial Aviation

ACCORDING to Rex Martin, assistant director of the Bureau of Air Commerce, who hopped to Miami from South America in time to spend the holidays on his native soil, America still leads the world in commercial aviation. "But," says he, "America will have to keep on its toes to meet determined strides now being taken by the Dutch, Germans and French."

Mr. Martin was official delegate of the American government to the International Aeronautical Exposition at Paris, and spent several months inspecting European airlines. "Dutch and French lines are perfecting standards of travel," said he, "and the trans-Atlantic commercial flights are making strong bids for trade that only constant improvement and watchfulness will succeed in holding for American lines.

"British flying is improving, too," continued Mr. Martin, "and the famous Imperial lines are doing 'remarkable things,' facing handicaps of serving 22 different countries, each with its own language and its own customs barriers. The Italians, while they have not yet seriously entered the international commercial field, hold the world speed record."

Mr. Martin is most optimistic over the possibilities of South America. He declares there is a wealth of blessings lying open to the people of the United States if they will only hold to the vision and have energy to go after it.

How to Enter the U. S. Air Corps

by **T-2003**

Here the author answers in detail the oft asked question "How can I join the Army Air Corps?" This article is authentic and is revised according to recent orders.

THEY tell me that many hundreds of letters are received each month by the Army Air Corps in Washington, D. C., containing as the gist of their query that eternal one, "How can I be an army flyer?" These letters are in addition to the ones received and answered by the commanding officers of various Air Corps fields throughout the country.

Assuming that the letter is readable and understandable, although many aren't, the Air Corps invariably mails the inquirer a mimeographed form reply to his questions. This form letter contains the list of qualifications necessary for appointment and a description of the flying course that the student undergoes. It sometimes includes a sheet describing enlistment as a soldier (mechanic) in the Air Corps.

To save the readers of POPULAR AVIATION the trouble of writing to Washington for the above information and to describe many matters which the Air Corps cannot by policy include in an official document, this article is written.

The supreme moment in the life of a flying cadet—the graduation exercises at which he receives his "wings." From this time on, he is an officer in the United States Army Air Corps, a position envied by thousands of our readers.

AN AIR CAREER THROUGH WEST POINT

FLYING CADETS and army officers are the only two classes of personnel taught to pilot airplanes by the Army Air Corps. The *latter* are practically all young men who have just graduated from West Point, have been commissioned in some other branch of the service like the Infantry, Field or Coast Artillery and who, if they can pass the physical exams for flying, are detailed at their own request to the Air Corps to take pilot training.

If they pass the course successfully they are transferred to the Air Corps, which is still a branch of the Army like the Infantry. If they flunk they go back to the branch in which they were originally commissioned.

Here is an idea of the proportion of West Pointers who take and complete flying training after graduation:

1. Graduating Class at West Point —256.

2. Of above graduated, those who desire to fly—128.

3. Those who can pass physical exams—64. (These lucky 64 start flying training.)

4. Those who successfully pass flying course—32.

The Baker Board, convened last spring to consider Air Corps matters, recommended that army officers serve at least two years in some ground branch before entering the Air Corps. While this recommendation is looked on with disfavor by many experienced airmen (it will irrevocably steal away from the flying game two of the best years of learning and adaptability that a young man has) it is quite certain that this recommendation will be carried out by the War Department.

Why I have devoted so much space to the West Pointer in flying is this—that many young men, anxious for a permanent career as an army flyer and seeing entrance into that career only through the portals of the United States Military Academy have sought appointment there, intending upon graduation to try for the Air Corps. Some of these lads are not twenty years of age; too young for Flying Cadets.

Until the present, entrance to West Point has meant a four-year delay in taking up flying. With two years to serve in the ground forces, after graduation, it may hereafter mean a *six-year* delay. However, a favorable angle to the situation arises. The Baker Board also recommended that a short flying course be instituted in the Military Academy curriculum and details of that scheme are being worked out at present. It is understood that 20 hours' flying instruction will be given. This may result in determining those who can later take the complete flying course profitably; and those who never will learn quickly and thoroughly enough for army standards. In other words, it appears as if West Pointers of the future will get *some pilot* instruction while cadets at West Point, where they previously got only a few hours of not-so highly-organized *observation* practice after three years at "the Point," but that after graduation they will have two years' doughboy work before being allowed to hit the air in earnest.

ADVICE—If not yet 20 years of age and eligible as Flying Cadet (see next paragraph), try for West Point. It's great training and will give you a fine background for later service in the Air Corps. Apply to your Representative or Senator in Washington, D. C. If you think you won't like army discipline it's certain you won't like that at the Flying Cadet School which is not for those who "can't take it."

FLYING CADETS

THE other and more numerous class of men taught to pilot army airplanes are the Flying Cadets. They are appointed from the following classes of unmarried, white, male citizens of the United States (first papers not sufficient) between the ages of 20 and 27 years inclusive:

a. (1) Graduates of the Military, Naval or Coast Guard Academy who were not commissioned due to lack of vacancies in their service and who apply as Flying Cadet within one year thereafter.

*(2) Enlisted men of the Regular Army Air Corps.

**b.* Enlisted men of other branches of the Regular Army.

**c.* Members of National Guard

Air Corps units, recommended by their commanding officer.

d. College graduates who are graduates of Air Corps R. O. T. C. units.

e. College graduates who are graduates of other R. O. T. C. units.

f. Graduates of *recognized* colleges and universities.

**g.* Other members of the National Guard.

h. Students in Air Corps R. O. T. C. units who have completed their junior year.

**i.* Reserve officers and members of Enlisted Reserve Corps.

j. Students in good standing of recognized universities, who have completed their sophomore year.

k. Others.

**Means that these applicants must have at least 11 months' service in their outfit before they receive any priority consideration.*

THE MENTAL EXAMINATION

AT present the majority of appointees are college graduates. Men who have not had at least two years' college work must pass a written examination in lieu thereof. The exam is a stiff one, and in the following subjects, United States History, Plane and Solid Geometry, Elementary (Oh, is it?) Physics, English Grammar and Composition, Geography, Arithmetic, Algebra, and Trigonometry.

THE PHYSICAL EXAMINATION

THE physical examination taken by all army flying training candidates is a tough one. Surprising as it seems, only about half the West Point graduates desiring to take up flying can pass this exam, and West Pointers are pretty good physical specimens to start out with.

The prospective Flying Cadet must have perfect eyesight and ocular muscle balance, no astigmatism or other imperfections of eyesight. He must have a good heart and hearing and be O.K. organically. He need not be a physical superman, a weight lifter or a big-muscle boy, but he *must* be a good normal physical man.

The physical examination is the first exam you take. ADVICE—Save yourself and the examining board trouble by first undergoing a preliminary examination by your family physician before traveling many miles at your own expense from your home to the place of examination, only to find there that you were palpably unfit physically.

These places of examination are scattered throughout the country, generally where there is an army air field.

CLASSES STANDING CHANCE OF APPOINTMENT

As the number of men *qualifying* for appointment far exceeds the number that can be actually appointed and trained, the best men obtainable are *appointed* so that the maximum number may be graduated. Accordingly, only those classes of candidates down to and including class "*f*" can be appointed at present, and unless something unforeseen occurs it is quite unlikely that those in classes "*g*" to "*k*" will ever receive appointment.

Boiled down, it means that to receive an appointment as Flying Cadet one must be either:

1. A graduate of West Point, Annapolis, the Coast Guard Academy or a recognized college, or

2. An enlisted man of the Regular Army or an officer or enlisted man of the National Guard Air Corps.

Also those in class "2" above, who have not had two years' college work must be able to pass the written examination previously mentioned.

ADVICE—Don't be discouraged by all those military titles and designations, but read the rest of the article.

HOW TO QUALIFY FOR APPOINTMENT

FEW, if any, applicants who have *not* graduated from high school are able to pass the written mental examination given in lieu of two years' college work. Let us suppose that, although you are not in one of the two

Trying him out on the "wobble-meter" in an Air Corps physical examination.

classes mentioned under the heading, "CLASSES STANDING CHANCE OF APPOINTMENT," you feel you have the following attributes necessary to pass the entrance exams:

1. Fine physique and physical condition.

2. Good moral character.

3. Unmarried, white, male citizen of the United States.

4. Age—between 20 and 27 years, inclusive.

5. At least two years of college work or ability to pass the written exams.

Now, you might pass all the exams and *qualify* for appointment yet not have high enough priority to *obtain* appointment. The question then is—how can you obtain a higher priority? Several methods are open. (We are assuming that you are not a West Point or Annapolis graduate and are not able to graduate from college.) You can enlist in the Regular Army, either the Air Corps or some other branch, as a private, a soldier. Or you can enlist as a soldier in an *Air Corps Squadron* of the National Guard. After eleven months' service therein, and if you have passed or can and do pass the examinations and are recommended by your Squadron Commander, you will receive appointment as Flying Cadet and start flying training.

The nearest Army Recruiting Station can give you dope on enlistment in the Regular Army. Such work is dignified and worthy of consideration and will be described later. Some of our greatest generals were once buck privates; General Benjamin D. Foulois, Chief of the Air Corps, for one. It is a full-time job.

It pays at least $21 a month and board —while you are learning the profession of a soldier or aviation mechanic waiting for your appointment as Flying Cadet. Or you might enlist in a National Guard Air Unit if one of the nineteen such squadrons are near your home. These are located at, or near:

Boston, Mass.; Hartford, Conn.; Staten Island, N. Y.; Newark, N. J.; Philadelphia, Pa.; Baltimore, Md.; Cleveland, Ohio; Los Angeles, Calif.; Minneapolis, Minn.; Nashville, Tenn.; Birmingham, Ala.; Little Rock, Ark.; Indianapolis, Ind.; Chicago, Ill.; St. Louis, Mo.; Denver, Colo.; Spokane, Wash.; Detroit, Mich.; Houston, Texas.

Complete addresses of the above units may be obtained from the Chief, Militia Bureau, War Department, Washington, D. C., or if you live in any of the nineteen states listed above you may get the further information from the Adjutant General at your state capital.

Duty in the National Guard is a *part*-time job. You get about one day's pay a week for drills. You should address your inquiry regarding enlistment to the Commanding Officer of the squadron in your state. Enlistment in an infantry or artillery or anti-aircraft company of the National Guard will *not* give you the necessary priority for appointment.

ADVICE—Before thus obtaining a higher priority by enlistment in the army or the National Guard Air Corps there is one important bit of advice that should be followed—*first take and pass the examination, physical, and if necessary, mental for Flying Cadet before you enlist.*

Unless, of course, you flunk, not too badly, in one or two subjects on the written examination and figure you can make them up in the eleven months you are in the regular or guard service.

HOW TO APPLY

LET us assume that you are one of the lucky and confident lads who believe themselves qualified to pass the examination. You write to either: The Chief of Air Corps, War Department, Washington, D. C., or The Adjutant General, War Department, Washington, D. C., stating that you feel qualified and that you desire application blanks for Flying Cadet. You are sent application blanks which you must fill out as directed, and return, including a

(Continued on page 265)

The New Sectional Airway Maps

by MAX KARANT

The most recent service rendered to flyers by the Bureau of Air Commerce is a series of airway maps on which all necessary flying information is noted. These maps take the place of the older strip maps and are complete in all details.

EIGHTY-SEVEN complete sectional airway maps, covering the entire United States, will be available to the flying public by June 30, the Bureau of Air Commerce revealed recently. The Bureau of Engravings is busily turning out large numbers of the new maps and will continue to do so until the project has been completed.

A Public Works Administration grant of $508,000 has made this boon to airmen possible. Work on these maps is, at present, so intense that, under the old map-making program, ten more years would have been required to complete them. Today, Eugene V. Vidal, Director of Air Commerce, is confident that the new maps will be available in complete sets within the next six months.

In keeping with the terms of the PWA grant, which requires that the work be done on a large scale and provide immediate employment for the greatest possible number of persons, the Bureau has already added over 100 new workers and new aircraft and equipment have been purchased. Twenty-eight of the new maps have already been completed and are now in circulation. The remaining months will be devoted to the final 59 that have to be compiled, checked and printed.

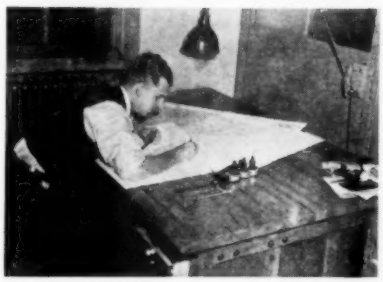
The old airway strip-maps, which only followed airways and showed strips of territory 80 miles wide and of varying length, have been discontinued and will be replaced by the new sectional maps which are about 40 by 20 inches in size and cover an area about 325 miles from east to west and 150 miles from north to south. The sectional maps are drawn to a scale of 1:500,000 which is equal to approximately 8 miles per inch.

Great detail is followed in the making of a sectional airway map. An accurate chart of the territory that shows federal and state highways, elevations, political boundaries, cities and towns, railroads, rivers and lakes is first drawn in black and white.

Features that are particularly helpful to airmen such as airways, airports, revolving and flashing beacons, radio stations and range beacons, and magnetic variations are shown in red. The radio range beacon courses are shown by bands of transparent pink. Red lines that serve as warnings to pilots in bad weather indicate the presence of elevated transmission or electrical power lines such as are carried on high steel towers.

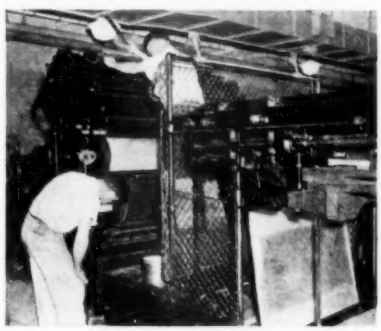
Rotating and flashing Department of Commerce beacons are indicated by red stars. Lighthouses along the Great Lakes or the seacoasts are shown as an aid to night flying. These maps also show the names of even the smallest towns and post offices.

A portion of a completed sectional airway map.



Completing the final draft of a Bureau of Air Commerce airway sectional map.

Correcting and retouching a negative of a sectional airway map preparatory to making a print.



A press on which the sectional airway maps are printed.

Astonishingly, the above is merely the first step in the making of these charts. Every scrap of information that can be obtained from every conceivable source including automobile road maps, state, county and railroad maps, blue prints of power transmission lines, Geological Survey maps, Forest Service maps and scores of others is carefully checked and placed on the basic map.

If any of the sources disagree the section in question is usually checked by a flight checker in an airplane. When proofs have been made of the basic map they in turn are checked by the flight checker who flies over the entire area shown at an average altitude of 5,000 feet verifying all the map's features. He lands at every airport and landing field shown to make sure that they are still available for use. These and dozens of other details go to make up the flight checker's job.

Once the flight checker turns in his map with his corrections penciled on its margins, it is returned to the drafting room where the necessary changes are made. Proofs of the map are then made in a non-photographic blue. Several copies of this blue proof are supplied to the map maker as he must make a separate plate for each color to be printed. The details for each color plate are traced in black over the lines of the blue proof. When this drawing is photographed for plate making, only the black registers as blue makes no impression on the photographic plate.

This entire process must be repeated for each of the four basic colors used on airway maps—black for boundaries, etc., brown for elevation and contour, blue for lakes, rivers and oceans and red for airway routes and features aiding in aerial navigation. The pink for the radio range beacon courses and the yellow that marks cities also require separate plates. Some maps even use as many as 18 plates.

Each map must be run through the presses once for each color. This is done several times until the complete chart with its many tints is ready to be sent to the stock room for final touches and distribution.

Even though the map has finally been completed there are usually several last-minute alterations and replacements to

(Concluded on page 264)

The Stearman Model 73 Navy Training Plane

The Stearman "73" Navy trainer is a new note in training plane design.

THE new two-seated navy primary training plane, developed by The Stearman Aircraft Company, Wichita, Kansas, for the United States Navy, is designated as Model 73 and is equipped with a 220-horsepower Wright engine.

The fuselage is of welded steel tube frame, fabric covered. The landing-gear is of the full cantilever type, oleo equipped. The tail wheel also is of the oleo type. Back of the rear cockpit is a luggage compartment for cockpit covers, luggage and all necessary equipment.

The tail group is of normal welded steel tube construction. The stabilizer is fixed, with horizontal trimming being effected by the use of an elevator tab.

The wings consist of laminated spruce spars, spruce ribs and aluminum alloy channel drag struts, all fabric covered. The interplane and cabane struts are of streamline steel tubing. Ailerons are of riveted aluminum alloy construction, fabric covered.

This navy trainer climbs to 5,000 feet in eight and eight-tenths minutes and also climbs to 14,000 feet as a service ceiling. It has the ability, too, to take off and clear a fifty-foot obstacle within seven hundred fifty feet in still air with full load and to land over the same obstacle within the same distance. It has maximum visibility, maneuverability and controlability, and easy accessibility of parts for inspection, maintenance and repair.

Its full speed at sea level is one hundred twenty-five miles per hour, stalling speed at sea level fifty-one miles per hour and endurance at full speed two hours. The full performance of Model 73 is given as follows:

PERFORMANCE

Full speed at sea level	125 m.p.h.
Stalling speed at sea level	51 m.p.h.
Climb to 5,000 feet	8.8 min.
Service ceiling	14,000 feet
Endurance at full speed	2 hours
Endurance at 60% V max.	6.5 hours
Range at full speed	250 miles
Service range (at 75% V max.)	430 miles

The Stearman Aircraft Company has an order to make forty-one of these training planes for the United States Navy for use at the new navy land-plane training school at Corley Field, Florida, which is to be operated in connection with the navy training base at Pensacola, Florida. Stearman's will also manufacture some spare parts for these planes which will make their whole contract equivalent to making a fleet of about fifty planes.

END

A Reactor Type Propeller Developed

RECENTLY, two Chicago inventors have produced a multivane reactor type propeller to take the place of the more common "stick" type.

Essentially, this consists of a series of revolving discs with small vanes or blades arranged around the periphery of the discs after the manner of a turbine. The discs are enclosed with a housing so that the air enters the front end of the housing and is rejected toward the rear, thus producing thrust by the reaction of the air stream.

The test reactor measures only 2'-6" in diameter and yet will absorb the power of a 160 h.p. aviation engine, giving about 5 percent more thrust than the best stick type propeller yet tried on this engine. The small diameter and the fact that the running parts are protected by a housing allows short landing gear struts and eliminates the danger of the old type propeller.

The Radio Beam "Ghost" Mystery

IN bad weather, when an aviator cannot see the ground, radio beams are often a real source of help to keep him on his course. But again they may be a real source of trouble and instead of keeping him on a true course they may be luring him away in the same fashion that the song of the beautiful sirens led ancient mariners onto the rocks.

The "on-course" radio signal, or radio beam, is a steady hum in the radio receiver. After a few seconds this hum breaks and the call letter of the sending station is repeated in dots and dashes which is followed by the hum for a time and then the repetition of the dots and dashes. If a pilot is off his course the radio beam signal is a dot and dash, or a dash and dot, according to which side the plane is off the regular course.

Where an aviator is purposely going off his course to avoid a storm the off-course dots and dashes buzz in his ears but suddenly a break in the repetition occurs and the steady hum of the on-course signal comes in just as it would were the plane on its regular course.

This "ghost" beam has led aviators off their course and has caused the loss of valuable time and even endangered lives over mountainous country.

Several scientists at the University of Wisconsin investigating this phenomenon believe that the radio beam "ghost" is not caused by electric charges thrown from the sun by sun spots, but is probably the result of surface conditions of the earth and the relative degrees of conductivity of different earth surfaces.

The sun spot theory has been discounted by C. M. Huffer, professor of astronomy at the University of Wisconsin, who admits that an electrical field does surround the sun, and electric currents, both charged positively and negatively, are sent out. Prof. Huffer explains that although these currents penetrate the earth's atmosphere, the radio beams do not probably reach high enough to come into contact with them.

Belief that the "ghost" beam originates in surface conditions of the earth and relative degrees of conductivity of different earth surfaces has been expressed by Prof. Edward Bennett of the electrical engineering department of the Wisconsin University.

A radio beam moves across a copper plate in a vertical direction and even on sea water, which is considered the best natural conductor, the beam's motion is vertical. A moist meadow is a good conductor and over such a surface the deviation from vertical is not extreme. But over earth surfaces where rock and sand predominate, he claims, the angle of declination is extreme. Because of the uneven distribution of

(*Concluded on page* 268)

The Model CT-32 Condor Carrier

This cargo carrying Curtiss-Wright Condor, Model CT-32, is basically the same plane as the Air Corps Type YC-30 Condor but adapted to general transport work instead of military service.

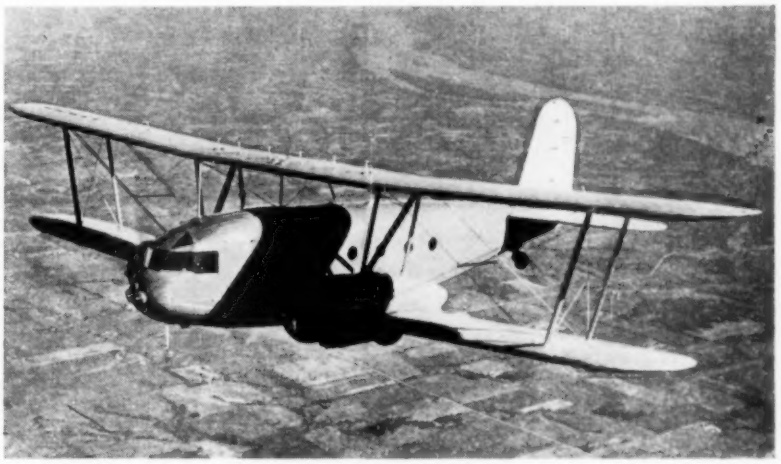
THE Curtiss-Wright Condor Cargo Carrier, Model CT-32, is a twin-engine biplane, basically identical with Air Corps Type YC-30 Condor, and equipped for general transport and cargo use.

It is so arranged that it can be provided for carrying troops, wounded personnel, general freight, cafeteria equipment, spare engines, parts, gasoline or civil passengers. Special attention has been given to the cargo features, and equipment is provided for conveniently loading, unloading and storing such material.

The construction of this machine is quite conventional and care has been taken to use only standard materials. In order to reduce maintenance and repair to a minimum, the detail design has been kept as simple as possible, consistent with load-carrying capacity.

As a troop transport, four folding benches are carried, which will seat 16 soldiers with ample space remaining for packs, rifles, etc. As an ambulance ship, six welded steel litters are provided. These are supported in the front of the cabin, three on each side, leaving the remainder of the cabin clear for other personnel or equipment. As a cafeteria, ample space is provided for any desired kitchen equipment.

As a freight carrier, a monorail hoist, loading ramp, removable rear floor, block and tackle and hold-down eyes are provided. The monorail hoist consists of a rope-driven screw hoist and trolley which runs on an aluminum alloy beam. The I beam is supported over the door by two diagonal steel tubes with welded fittings. Attachment is made at the ridge pole on the center line of the door by a screw fitting.



The Curtiss-Wright Condor, Model CT-32 in flight. It has a useful load capacity of 6,738 pounds and a high speed of 177 m.p.h.

A small automobile can be carried with ease.

The track can be disassembled merely by unscrewing this fitting, and with its supports is stowed aft of the cabin in brackets provided for it. A removable section of flooring brings the door sill level when the tail of the ship is on the ground. Two channel sections provide a ramp on which standard engine dollies can be rolled aboard the ship. This also can be done with the hoist. For moving freight, engines, etc., forward in the ship, with the tail down, a block and tackle is provided. Fittings in the floor provide anchorage for standard engine dollies.

The standard cabin furnishings include 10 pyralin windows of 12½" diameter; a main entrance door; two emergency exit doors, one on either side of the cabin centrally located; a hatch in the pilot's compartment for fueling and servicing; a hatch just aft of the cabin in the floor for parachute exit and the dropping of food and other items in containers by parachute; a first-aid kit; a lavatory seat, a complete cabin heating installation with 12 individually-controlled outlets; and also two cabin dome lights which include air exhaust ventilating units.

The interior dimensions of the fuselage available for cargo space:

Length . . . . . 22 ft.
Height . . . . . 6 ft. 6 in.
Width . . . . . 6 ft. 3 in.

with a main cabin door constructed of aluminum alloy sheet, and with a similarly constructed hatch, making available a clear opening of 6 feet 6 inches in height and 6 feet in width.

The fuselage proper is constructed of welded 4130 steel tubing. Five longerons—2 lower, one right and one left upper, and one center—are used in the region of the cabin, the upper right-

Side elevation of the Curtiss-Wright Condor showing cargo door at the left.

hand one being omitted at the cargo door. A rigid arch is trussed in the plane of the front wing beams, and behind and ahead of the cargo door.

The cabin floor structure is fabricated from aluminum alloy stringers and arches riveted into sections. The sections attach to clips on the lower longerons and the keel, which runs longitudinally under the center of the cabin compartment. The metal floor structure is covered with 3/16" birch plywood secured with machine screws. The pilots' compartment floor consists of an aluminum alloy corrugated section covered with a flat aluminum alloy plate. This unit bolts to the supporting structure, which is welded to the fuselage.

The balance of the airplane, including the wing group, tail group, engine nacelle and cowl, landing-gear, etc., are of conventional Condor transport construction.

The basic crew arrangement consists of two pilots, and standard airline navigational facilities and engine instruments are provided, including blind-flying instruments and two-way radio installation.

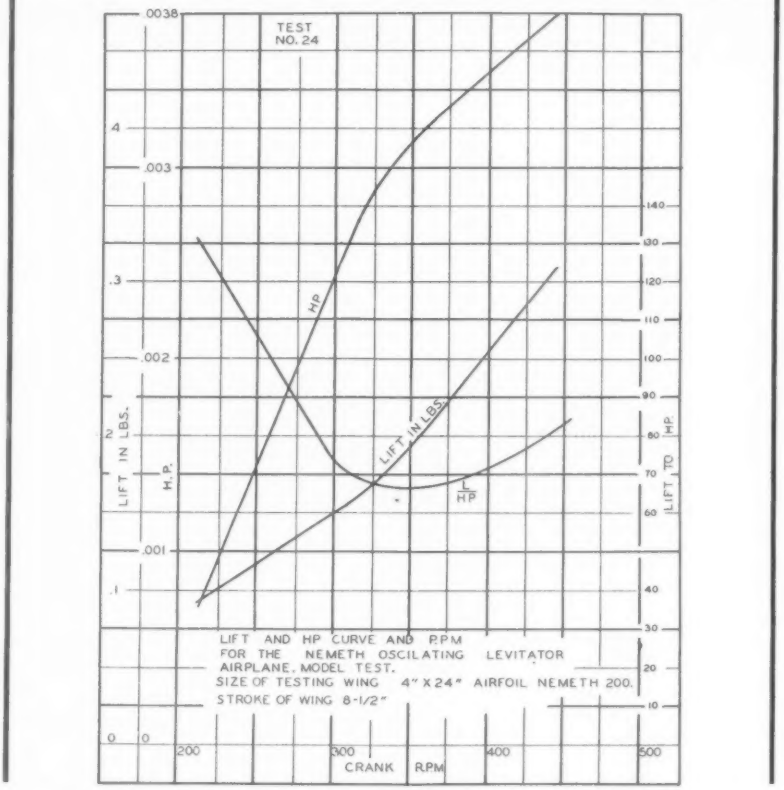
The power plants consist of two R-1820-25 Wright Cyclone engines, 750 horsepower each, driving Hamilton-Standard propellers of the three-bladed controllable-pitch type.

SPECIFICATIONS

Wing span, upper	82 ft.
Wing span, lower	74 ft.
Length overall	49 ft. 7 in.
Height overall	16 ft. 7½ in.
Weight empty	11,762 lbs.
Useful load	6,738 lbs.
Gross weight	18,500 lbs.
High speed	177 m.p.h.
Service ceiling with design load	20,000 ft.
Time to climb to 10,000 ft. with design load	10½ minutes
Cruising range	750 miles
Landing speed with full load	58 m.p.h.

Lifting a steel drum aboard the Condor.

The Nemeth Levitator Shows Results



Performance graphs for the Nemeth Levitator show that this device is unusually effective.

S. P. NEMETH, a pioneer aeronautical engineer of Chicago and a well known inventor, has been conducting extensive experiments upon levitators of various descriptions. He has been unusually successful in this direction and we show the graphs taken from a test made on his most recent development.

Because of the present patent situation, we are not able to print a full description of this levitator in this issue, but as soon as we obtain permission from the inventor, our readers will be given a full story of the device and its mode of operation. The whole affair is highly ingenious and will be an inspiration to those who are working along parallel lines.

We cannot do better than to present Mr. Nemeth's letter on this subject which was received at our offices a short time ago and quote a visit that he made later to our office.

During the year 1926, when I was developing my last rotary wing airplane, the levitation or oscillation airplane idea occurred to me. I had built one model, but on account of the great mechanical difficulties arising in this model and because of lack of time, I had to drop it.

In POPULAR AVIATION of December, 1933, page 369, I read an article by John B. Rathbun, "What About Levitation—Yes or No?" This article revived my old interest in an idea which I had almost forgotten and it took great determination to fight off the desire to tackle this great mechanical problem involved in this idea of flying. But, being very busy on the development of my circular wing airplane, I put this article in my files to be forgotten for the time being.

In October of 1934, while digging through my files, the Rathbun article on Levitation again came into my hands. This time I decided to do some research work on this Levitation idea, despite I was very busy with other work.

During October and November of 1934, I built and tested 16 different models, starting with a metal sphere and then advancing to cylinders and different wings. I finally overcame these mechanical difficulties which had surrounded the oscillation problem of flight . . .

. . . I sincerely believe, from years of experience with the vertical rise problem, that the oscillating wing fulfills the dream that inventors and engineers have had in mind and have attempted to accomplish with the helicopter idea.

If you wish to see this model and test results and performance calculations, based upon the design of the model, I shall be at your service upon a call from you.

A portion of this letter was necessarily deleted.

A Few Pointers on Airports

by KEITH J. FANSHIER

A discussion in which the matter of airport location is taken up with a view of improving urban transportation to and from commercial airline ports. No matter how well equipped an airport may be, it has a negligible value if it is not within easy reach of the city.

IF aviation is going to get anywhere near the goal it should achieve to fulfill its manifest destiny, then it must have help. And here are the types of help which it just must have—and have without being forced to wait too long.

The ideas which follow are not simply those of the author of this article. They are based on the opinion of dozens and scores of representative people in aviation and in positions outside aviation with good perspective on it.

They are the composite results of discussions instigated by this writer in the last few months with: aviation company executives, workers of all kinds in aviation (who, by the way, are not so dumb about their industry), air-minded members of the public, officials of companies using air transport extensively, ship designers, high governmental officials and many others including those primarily with interests of aviation primarily at heart as well as those not so closely interested in aviation but desiring sane and sound development for the future good of the country.

Here is a boil-down on the views in six main sections:

1. A complete revolution in the theory and practice of airport location, especially in metropolitan centers. This is vital and must come soon.

2. A subsidy—government dollars—that is a real subsidy, "heavy money," not just a little sop thrown to a starved giant to keep him quiet.

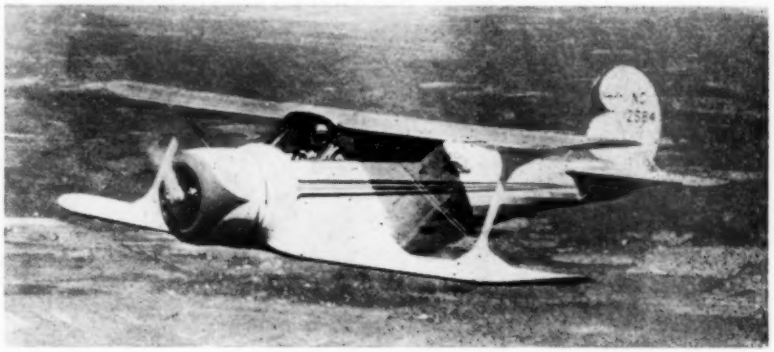
3. Freedom to develop in natural channels dictated by its economic and useful destiny without too much "dead hand of regulation" strangling it, although the need of intelligent supervision by some authority on certain phases is generally admitted.

4. Stimulation and development of air-mindedness in the youth of the nation, capturing the imagination of virtually every boy and girl in the whole country, and firing those young and energetic minds with possibilities.

5. Building up on a grand scale, not a meager or stingy scale, of aviation in military and naval affairs.

6. The giving of full play to research which should mean discovery of and experimentation with materials and processes which would completely change aviation's position and would dwarf the potentialities hitherto considered to attach to it. This, of course, would, and will, lead logically into the last point—

7. The building of finer, better flying equipment.



This Beechcraft is one of the three Socony privates used by the officials of this oil company. Just one more view of the commercial importance of airplanes.

These are lines along which the people who really are doing and thinking in aviation are looking. They are not at all a duplication of the recommendations recently made by the federal government administration's commission on aviation.

First, the matter of airport location.

Now here is a little tip, which does not seem to have occurred to many leaders in the industry of aviation. There are billions of dollars of public funds which have been spent in the last two years in construction and work projects of various kinds. There are more billions to be spent, in all probability in the next few years. These projects are in the main those which the government favors on the theory that they will make work for large numbers of men, or that they fall within that somewhat elusive, vague category of being "self-liquidating." To the fullest extent the re-location and the construction of better, newer airports complies with the letter and the spirit of both of these requirements.

From the general aspect of the Washington situation, everyone and every plan and scheme and every industry is getting federal funds. Why not aviation? When it comes to getting federal funds, the matter of new airports looms large. The Chicago tangle is a case in point, but it is only one. Vast numbers of men would be given employment in the re-location and construction of new airports in a dozen metropolitan centers. It has been estimated that as many as half a million men would be given work for two years in such work—certainly an undertaking not to be sneezed at in any general consideration of work relief.

The amount of money required for a dozen such airports would be negligible compared with the amounts being passed out by the government on other undertakings. For instance, a rough estimate, based on fairly well-established plans for the dozen airports would be that they could all be handled for a total cost of much less than $100,000,000—perhaps only $50,000,000. A few years ago such figures might have frightened anyone. Today, they are "chicken-feed" in comparison with the vast amounts being ladled out here and there. Considering that these projects are of a type considered by authorities to be self-liquidating, there need be little alarm about the economic common-sense of the plan.

The case of the Chicago airport location controversy is attracting attention the nation over. The best guess at this time—although it still is only a guess, is that despite predictions to the contrary, Chicago will get its lake-front airport, accessible from downtown in ten minutes, thus cutting off at least three-quarters of an hour from the ridiculous necessity of a motor trip toward a suburb of unsavory gang-land reputation, requiring as much time as an air trip to Toledo or beyond.

Comparatively small grants and sizeable loans from the public works administration apparently are all that are required for work of this kind. Hangars, terminal buildings, runways, aprons, ramps, bridges, sodded field and all the other equipment and appurtenances of the modern airport can and should be provided for.

In the case of the Chicago situation, there have been many peculiarities of interests and interlocking and interlacing angles uncovered since the question of re-locating the airport came up. The lake-front is the logical spot for the field and an area of 200 acres has been plotted on engineers' blueprints, extending from Randolph Street south to Twenty-eighth Street, and occupying an area far out into the lake. The

foundation will be provided by filling in the lake with sand and cinders within an area strongly enclosed by pilings. Over all would be poured a protective covering of soil.

A great deal of objection to the lake-front airport has been disclosed, much of it alleged to be from selfish motives. However, most of the objections have been disposed of. Noise from motors probably would not be objectionable. From the scenic and aesthetic standpoint, no permanent or fundamental objections can stand up. Any possible element of danger in connection with effect on property and persons is eliminated by reason of the fact that the proposed airport would be entirely removed from private property. It is now planned that in the event the plan is realized, the old airport at Cicero and Sixty-third would be continued in use, but as a training and repair field.

The question of a subsidy, the pouring into aviation of government money, partakes of some of the basic considerations which apply to money for airport construction. However, subsidies to industries closely allied to national defense are as old as the hills, and there would be no shock to the nation's legislators were they approached with the proposal to give a whacking large amount of money to greater development of aviation.

In fact, the approach ought to be managed in an efficient manner, and soon, in the opinion of many with whom this writer has talked recently. Aviation need have no qualms about making such claims for means to development. It is a part which it must take in safeguarding the country's security.

It is interesting to note the reaction of aviation people to the question of regulation, whenever it is brought up. Of course, there are naturally many differences of viewpoint on it. Not one of the many interviewed in the last few months has denied the need—the imperative necessity—of regulation in matters concerned with safety.

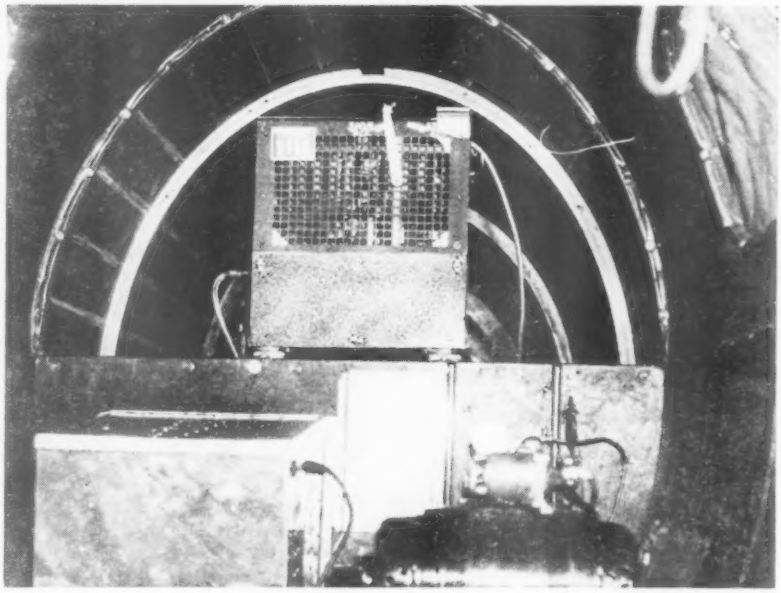
However, there is a decided opposition in many quarters in the industry to extension of regulation very far beyond that point. The recent report of the federal aviation commission has been attracting considerable attention, judging from the statements of those with whom this question was discussed. There is, however, hesitation to make sure that an over-all control of aviation by a transportation bureau which covers all other branches of transportation would be wise.

With a fast-moving and rapidly-developing young industry such as this, the expression is advanced by many that a more flexible type of supervision may be needed than the type of control ordinarily found to result from governmental bureaus, etc.

It is time to get aviation into the minds of the nation's young people to a much greater extent, it is believed,

(*Concluded on page* 262)

Radio in Amelia Earhart's Plane



The radio equipment used by Amelia Earhart on her flight across the Pacific which carried the spoken word from Honolulu to California, 2,200 nautical miles.

SPECIAL and extremely efficient radio sending and receiving apparatus was installed in Amelia Earhart's plane before it left Burbank, where, at the Union Air Terminal, exhaustive tests were made before the Lockheed was shipped to the Hawaiian Islands on the Matson Liner, Lurline.

In addition to a receiving set for beam-flying, the plane carried a special transport airplane transmitter manufactured by Western Electric. Night frequency was 3105 kc., day, 6210. Power generated from an automobile type generator to the engine in the nose of the plane, feeds a nest of storage batteries. These batteries lie near the radio apparatus located just aft of the fuse.age door in the stern of the ship. The batteries deliver current to a Dynamotor which carries the current to the high tension crystal controlled transmitter set. Call numbers of the plane were K H A B Q.

Tests made early in January by Paul Mantz, flying the Earhart plane 12,000 feet over Honolulu, carried his voice over the intervening 2,228 nautical miles of the Pacific to stations in California and Arizona and a broadcast message sent out by KFI acknowledged the reception immediately afterwards. Mantz received the return message through the headset as clearly as though he were in Los Angeles. The message from the plane was spoken into a new type of close contact microphone, which eliminates cockpit noises.

New 2-Cycle Engine Displayed at Show

A NEW 2-cycle engine of the double-acting rotary sleeve type was exhibited recently at the National Inventors Congress, Hollywood, Calif.

This engine, which can be used either as a Diesel type or carbureting engine, has 51 percent fewer parts than the usual type of aviation engine and is correspondingly less likely to develop mechanical trouble. The double-acting feature, while adding to the height of the engine, doubles the output per cylinder so that a material saving is made in weight. It is easily accessible for repairs.

It weighs 151 pounds complete and develops 88.8 horsepower. It is the only engine of this type that has force-feed oil to the rotary valves. F. A. Van Bezel, Los Angeles, Calif., the inventor has sixteen patents on this engine and has had it under development for some time.

The Van Bezel 2-Cycle engine.

My Experience in the Yukon

by WALT BOHRER

The Chief Pilot and Editor of "Tale-Spins" takes a few random shots at the airport pests who strut and swank about every hangar with tales of their prowess(?).

I'VE been listening to the braying knaves, who call themselves pilots, raking up so much dirt about their harrowing exploits while plowing through the ozone that I've decided to come down to earth myself and put a stop to such fallacious fabrications by digging up an experience of my own that would cause a laughing hyena to break down and cry.

Having hopped into northern Canada with three pontoon jobs to pick up a load of penguin pelts, which are used in this country for sweaters for Boston terriers, three of us pilots landed at Lake Needabathska in the middle section of central Yukon and proceeded at once to load up. As it had been late afternoon when we arrived, it was not long before darkness fell—doing no serious damage—and we were forced to make camp, there being no hotels in sight. After a bit of wide open space indigestion we dug in for our customary forty (40) winks which was cut to thirty-four (34) by the unscheduled visit of a Yukon blizzard skunk.

The extreme embarrassment and the picklement we were in can be well imagined when we poked our peepers out of our blanket of pelts the next A. M. to find a hot frost had blown in during the night, freezing the lake up tighter than a bull-fighter's pants, with the sad result that our pontoons might just as well have been buried in solid concrete.

Dear, dear, what to do? A session in a Louisiana crap-shooters huddle brought the answer. We would first load up, then get in and take off with the whole damn lake! And no sooner said than done.

With the throttles of three ships bent somewhere ahead of wide open, there was soon a resounding crack as the ice-plagued lake surrendered to the superior power of our three OX's—or rather our three Hornets—and we were off in a cloud of—mosquitos!

The drag of the frozen lake on our ships was so great that, try as we might, it was impossible to get over a thousand feet of altitude or more than one rev ahead of a stall. That would never do. So while one of us did the flying, the others—being good chiselers—got out and with hammers and chisels, chiseled the whole leading edge of the lake into an M-12 wing curve.

This M-12 wing curve gave the lake so much lift that we then couldn't keep from climbing, eventually arriving in the stratosphere where we ran out of gas. Even then we couldn't stop climbing, but kept right on going higher and higher!

After drifting about in the stratosphere a week or more, our food supply ran out which ordinarily—to an aviator—would come under the heading of a helluva note. However, we soon discovered that with a few sticks of dynamite we happened to have (the only way we could wake one of the boys up

An idealistic front elevation of Walt Bohrer (Not to scale). As neither our artist nor ourselves have even seen Mr. Bohrer—nor even a snap-shot—this may not be a faithful reproduction of Mr. Bohrer's physiognomy.

was to set off a charge of dynamite), we could blast herring out of the ice. This assured our food supply.

Loss of sleep in the frigid atmosphere soon put Arctic circles under our eyes, and to make bad matters worse, two of the boys ran out of cigarettes and were forced to resort to smoking herrings. If it had not been for the air supply in the inner tubes we were using for seat cushions, we would probably have suffocated to boot.

Sparks from the herrings, it seems, trailed in our wake and attracted the attention of astronomers at the Mt. Wilson observatory who thought they had discovered a new planet inhabited by a very low form of moron life. The latter assumption was later proven correct when it was discovered the inhabitants were transport pilots.

We must have been in the stratosphere 10 or 12 days when we finally drifted out over the Sahara Desert. There the terrific heat of the desert soon reached us and the ice began to melt. In practically no time the M-12 curve had been melted into a common Clark-Y, causing a very noticeable sinking sensation. The lower we went, for some reason the hotter the heat became until the ice was melting so fast the Sahara was experiencing its first general rainfall. This, in turn, was irrigating the desert and causing many varieties of vegetables to grow. Soon the entire ice lake had melted and we were left in another embarrassing situation—that of being over the middle of the Sahara Desert in pontoon jobs. However, being the hot pilots we were, we soon remedied the situation by gliding in and landing on the heat waves.

Once more back on terra firma we discovered that the rain had become so hot by the time it reached the sands that it had cooked the vegetables as they grew and we were able to sit down to a real meal of cooked vegetables! And what a treat that was!

Now had it not been for the fact that we had dressed for the rigors of a north Canadian winter we would probably never have been found out there in the Sahara. As it was, however, our long woolen winter underwear, as out of place in such a torrid climate as a skunk at a lawn party, commenced biting like a plague of red ants forcing us to leap about the dunes like a kangaroo with prickly heat.

Bang! Boong! More leaps and an investigation that chilled us even in that cracky heat. Sheets of copper flew past like sheets in a cyclone. Then the pungent fumes of petrol with a following wave of heat that would make hades comparable to liquid air. The gas—what was left of it—boiled and burst the tanks. No hope now, boys—we'd have to ankle it into the nearest port.

But an idea. The bottle of beer had been primed with hops—what about that? Uncorking the parcel of beer, we made rapid progress by hops and leaps.

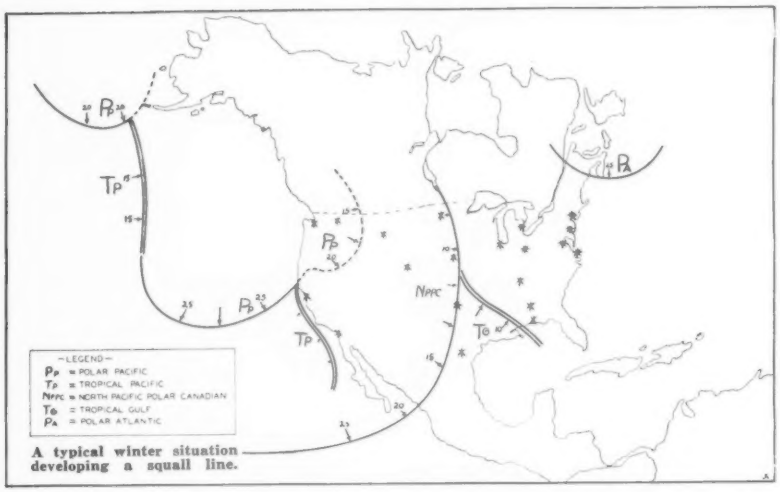
It was at the ceiling of one of these leaps that a sheik encamped a few miles away happened to see us and rushed over to buy a bottle of what he thought we had. Instead we wasted no time trading our three pontoon jobs and two red buttons for three of his camels and rode back to civilization still suspicioning the sheik of having traded the camels for the red buttons and not the ships!

And let that be a lesson to you!

The Elementary Theory of

by

JOHN R. MARCY



A typical winter situation developing a squall line.

A REVOLUTIONARY new system of atmospheric analysis, that brings startling accuracy to weather forecasting, has been developed and its value has been demonstrated in practical tests during the last eighteen months.

Called the "air-mass analysis method," it will result in improved operations efficiency for the nation's airlines in the movement of airmail and the air industry generally. As a result of these practical tests, together with extensive studies conducted at the California Institute of Technology and the Massachusetts Institute of Technology, the United States Weather Bureau nas decided to change over to the new method as rapidly as time and appropriations will allow.

The principle behind air-mass analysis is the recently recognized fact that air is not a single mass in itself, but is composed of numerous individual masses, each having distinct characteristics differing from the others, such as temperature, humidity, velocity, direction, and compactness. The interaction of these various air masses, some cold, some warm, produces conditions which can be forecast from 24 to 48 hours in advance.

The varying characteristics of the air masses involved in the forcast determine the type of weather, its intensity, the area which it will cover, and the speed with which it will travel.

Up to the present time, nothing new has been developed in weather forecasting methods for a period of 25 years. The classical methods depended almost wholly upon a charting of pressure areas, from which wind directions and the movements of disturbed air bodies could be charted with only a fair degree of accuracy. This was a two-dimensional method, taking into account only the width and breadth of air movements. While this system was fairly satisfactory for general purposes, it was dependent on the laws of probability and in critical cases had not been adequate for aircraft use.

The air transport pilot needs to know at what levels clouds are formed; when and where turbulent conditions exist so that he can avoid them by landing or flying around them; at what level smooth air will be found for passengers; the location of favoring and adverse winds; and when and where he may expect to find icing conditions. This information is now brought to him in regular reports through his radio receiving set.

A good many years ago meteorologists began to notice that there seemed to be distinct masses of air, and that changes in weather seemed to be related to the meeting of such masses. They noticed, for instance, that tornadoes occurred along the boundaries of contacting bodies of air. Classical methods, however, had such a hold upon the minds of men dealing with these studies that it was not until some ten years ago that any real theorizing on the subject was done.

About that time a group of scientists in Norway started a series of studies of air masses, their characteristics and movements and their possible relations to weather conditions. Three years ago the theory was introduced in this country and extensive studies under practical conditions were made by the California Institute of Technology and the Massachusetts Institute.

Eighteen months ago the General Air Lines offered the facilities of its air-route between San Diego, Los Angeles, Las Vegas and Salt Lake City for a practical demonstration of the new method's efficiency for aircraft operation. These tests were conducted in strict secrecy, and the results only given out after the method had proved successful even beyond the hopes of the experimenters. The flyers themselves, before the end of the test period, had come to depend as much upon these accurate weather reports as they did upon their motors, and air-mass analysis has now been adopted as the standard forecasting method throughout the system.

These tests demonstrated that the new method of weather forecasting was so accurate that Willis Gregg, new chief of the United States Weather

Free balloons are released at regular intervals . . . closely watched by theodolites.

the Air-Mass Analysis Method

Bureau, became interested. In June he informed Cal-Tech and the General Air Lines that every assistance would be given them in adapting air-mass analysis to practical use and that the Weather Bureau would change over to the system.

He immediately arranged for daily vertical airplane ascents at twenty different points scattered throughout the United States to gather data for use in plotting weather charts. Whatever the weather, every morning at about five o'clock airplanes ascend from these twenty flying fields. Strapped to the wing of each plane is a set of delicate instruments that automatically record the temperature, humidity, barometric pressure, and the direction and force of air currents at the various altitudes throughout the climb, which extends to from three to four miles. On descending this information is relayed by teletype to the central forecasting station.

At over a hundred other points additional information is obtained and sent in. Free balloons are released at regular intervals, and as they are driven this way and that by encountering winds of different directions at the various levels they reach, their course is closely watched with theodolites; balloons carrying automatic recording instruments similar to those carried by the planes are released and allowed to ascend until they burst, dropping the instruments on parachutes, to obtain information about the upper air to as high as fifteen miles; reports of weather conditions, including ground readings of temperature, humidity, and pressure, are made from these various points.

From this it will be seen that air-mass analysis is a three-dimensional study, taking into consideration not only the width and breadth of air masses but their vertical characteristics as well. The forecast now gives, in addition to the usual weather report, height of ceilings, cloud formations, and their altitudes, and detailed information on wind directions.

When Rickenbacker was planning his recent record-breaking flight across the continent, forecasts by air-mass analysis were furnished him and the time of the flight was determined from this data. His course was mapped out every foot of the way so that he would have the advantage of every available tail wind and no small measure of his success was due to this help.

The air masses that affect the American continent are divided into four general types—Polar, Arctic, Tropical, and Equatorial. Generally speaking, the Polar and Arctic air masses are cold and dry. As they move southward they develop very sharp differences in temperature between the upper and lower parts, due to the fact that the lower part of the mass is warmed by its

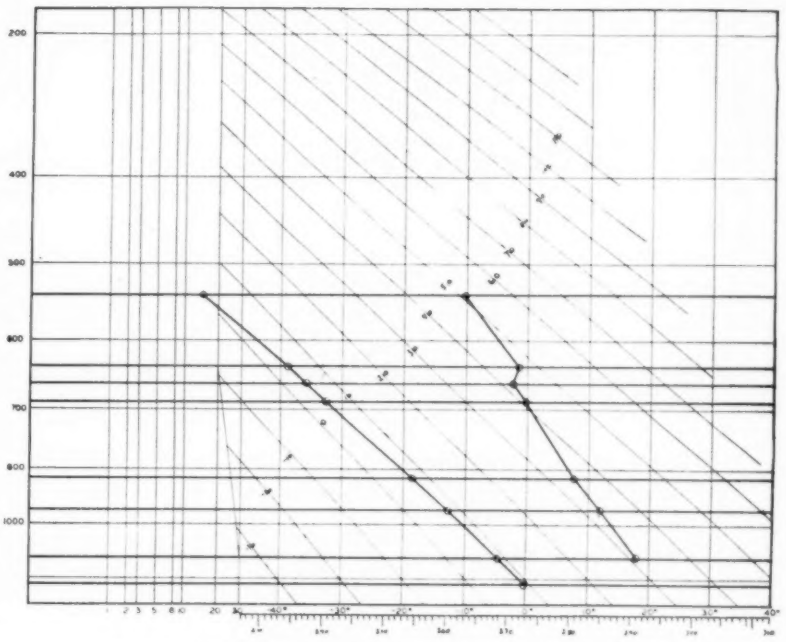


Chart for solving the forces that create varying weather conditions.

land and water contacts, while the upper part retains its polar temperatures. This causes a tendency to overturn.

That is, the warm air tends to rise while the cold air descends, causing this type to be very unstable as far as weather conditions are concerned. If a certain degree of humidity is present when this overturn occurs, squally weather results.

Tropical and Equatorial air masses are characterized by general warmness and high humidity. Being considerably more stable than masses of northern origin, weather conditions are more regular until these masses begin to meet others of differing properties. These differences between Polar and tropical masses are particularly pronounced during winter and early spring.

Such large bodies of air, hundreds of miles in extent, travel over the earth's surface for long distances from their points of origin and still retain the physical properties attained at their source. By allowing for the differences due to altitude the forecaster can determine from the station reports the exact extent of any given air mass. From a chart showing pressure areas, together with reports on velocities and directions, he forecasts its future movements.

When air masses of vastly different properties, such as vertical distribution of temperature and moisture content, are brought together, they do not mix to any great extent. The boundaries arising between the air masses may exist for days or even weeks at a time.

Cold air will always tend to underlie warm air, since it is heavier, similar to the action of oil and water. The boundary between oil and water, however, is a level surface, while in the atmosphere boundaries arising between different types of air are sloping surfaces, due to the deviating effect of the earth's rotation. The areas of bad weather in the atmosphere arise along these sloping surfaces.

A "cold front," where turbulent conditions occur, is generated when an outbreak of cold air from the polar regions sweeps south or southeastward, underrunning a warm body from the tropical regions. These outbreaks of cold air often have a depth of 30,000 feet or more and extend over large areas. The danger of flying through a "cold front," particularly in the case of large airships, is very great because of the rough conditions and possibility of icing.

When these northern air masses force their way into a warm current from the south, a compensating flow of the warm air occurs northward. This process gives rise to a low pressure area.

The "cold front" is generated between two air masses when a cold mass is underrunning a warmer one. The cold air aloft pushes ahead of the lower part of the same mass along the surface, due to the greater friction at the ground. This causes violent overturning, with the formation of horizontal whorls or vortices, which may have the intensity of tornadoes in extreme

cases. Such a "cold front" may have a breadth of hundreds of miles as it sweeps across the United States. As the warm air rises, due to the overturning, it expands and, if it is sufficiently moist, rain results.

The cold front is commonly called a "squall line," and it was such a condition that caused the Akron to be forced into the sea. These violent disturbances do not arise quickly in the atmosphere and may be predicted with great accuracy hours and even days in advance, provided a knowledge of the air masses involved is available. On page 226 is a weather map showing a typical winter situation that involves such a squall line. This is the forecast that was made from this map:

"The Polar Atlantic air mass moving southwestward over New England augurs cold, sleety weather for the New England states during the next two days. The region northeast of the Tropical Gulf warm front will have heavy rain. The area along the cold front running north and south over the central part of the country will have squally weather followed by clearing and cooler weather within twelve hours. California coastline is receiving rain from the Tropical Pacific warm front lying offshore, to be followed by showery weather with the advance of the Polar Pacific cold front, after the passage of which the weather will become cool and clear. A new outbreak of Polar Pacific air is seen in the Aleutian region."

The "warm front," the second general type of boundary between air masses, occurs when warm air runs up over a retreating wedge of colder air. As the warm air rises rainfall will result, the amount depending on the humidity of the warm air mass. Eventually the warm and cold fronts merge, and from that time on the disturbance decreases rapidly.

One day, early this winter, things looked bad around the Union Air Terminal at Burbank, California. A heavy rain was falling, and the way the clouds had banked up over the ocean it appeared to the lay observer as though the condition would continue for days. The report came out from the office, however, that the weather would be fine by morning. It explained that the warm and cold air masses responsible had stagnated, and that from then on the two would merge rapidly with clearing weather as a result. By morning not a cloud was to be seen.

The reports at times are even far more specific than this, with just as great accuracy. A pilot on one of the Douglas Transports, westbound, called in from eastern Utah. "Looks bad ahead. Believe I'm going to have to come down and wait it out." The terse reply crackled in his earphones: "You are, but not for long. There's going to be bad weather—squally—

(Concluded on page 259)

The Aero-Sportswoman

by JOAN THOMAS

THE Ninety-nines held a "housewarming" tea in their swanky new club rooms at the Gotham Hotel, 55th and Fifth Avenue, on February 7th. Mrs. Margaret Cooper, national president of the organization, received the guests. She was assisted by Clara Studer and Fay Gillis, editors of the magazine *Airwoman*.

It is a rare achievement to collect nearly a hundred air-minded persons together at one party, but when the guest list reads like a Who's Who in aviation, it is sort of a grand jubilee.

Amelia Earhart and her publisher-husband, George Putnam, who were celebrating their fourth wedding anniversary that day, were there. Amelia, who less than a month before had redoubled her fame by her Pacific flight, was especially honored by the unveiling of a sculptured head of herself. The artist, Mrs. James L. Clark, wife of the director of the Museum of Natural History, was present for the ceremony.

Col. Roscoe Turner, winner of last year's Thompson Trophy race and who placed third in the London-Melbourne race, added a bit of color and dash to the party. The Department of Commerce was represented by Inspectors S. L. Willets, O. P. Howard and Dr. Clara Regina Gross. Dr. Gross has the distinction of being one of the first women physicians to be appointed as a medical supervisor for the Aeronautical Division of the Department of Commerce.

Ruth Nichols, only woman pilot to hold three world records at one and the same time, Mrs. Mabel Britton, national secretary of the 99 organization and Alice Hirschman, governor of the North Central Section, were among those present.

Others famous in sporting events, racing and record-making flights, included Clyde Pangborn, Jessamine Goddard, Anrette Gipson, Peggy Remey, Mrs. Maude Tait Moriarty, Viola Gentry, Melba Beard, Dorothy Leh, Helen Worden, Marjorie Ludwigsen, Clayton Knight, and R. H. Depew.

Howard Starke, the blind flying expert, was there, also Mrs. Floyd Bennett and Mrs. Bella C. Laudauer whose very interesting collection of manuscripts, books and aeronautical music is so delightfully described in the January issue of *Airwoman*.

We don't know whether the new club rooms were occupied previously by some nautical society or not, but our New York correspondent reports that the walls are decorated with ships and sea background and there are life preservers hanging on the walls. (She suggests that the girls might replace the latter with parachutes!) However, many sketches and portraits of well-known flyers, the sculptured head of Amelia on the mantel above the fire-

Laura Ingalls, has added to her laurels. She is the first woman flyer to receive a Scheduled Transport Pilot's license. She can operate any plane on regular transport runs.

place, a beautiful ($600) model of a tri-motored airship on the table and aviation publications scattered about, add the necessary aeronautical atmosphere.

The beautiful new offices will serve as the New York headquarters of the 99s, W.N.A.A. members and Junior Birdwomen. And all women interested in flying are invited to visit the lounge whenever they are in New York.

* * *

Phoebe Omlie doesn't make the headlines so often these days since she gave up racing and attending air meets. But a number of things have come out of Washington, since she has been in the Aeronautics Division of the Department of Commerce, that show unmistakable signs of her influence. Some of these changes are not specially concerned with women flyers, while others are considered a great advance in the recognition of their rights and special problems.

One of the most important of these, is the appointment of women physicians as medical examiners for the Department of Commerce. The two alert young women who are now serving in this new field are Dr. Emma Kittredge on the West Coast and Dr. Clara Gross in New York.

Dr. Kittredge, who comes of a long line of doctors—nine generations of them in her family—served her internship in the Los Angeles General Hospital. Dr. Gross is a graduate of Johns Hopkins and interned in Bellvue Hospital in New York. We list these credentials merely to show that these young women are adequately prepared and that the research that they are do-

(Concluded on page 261)

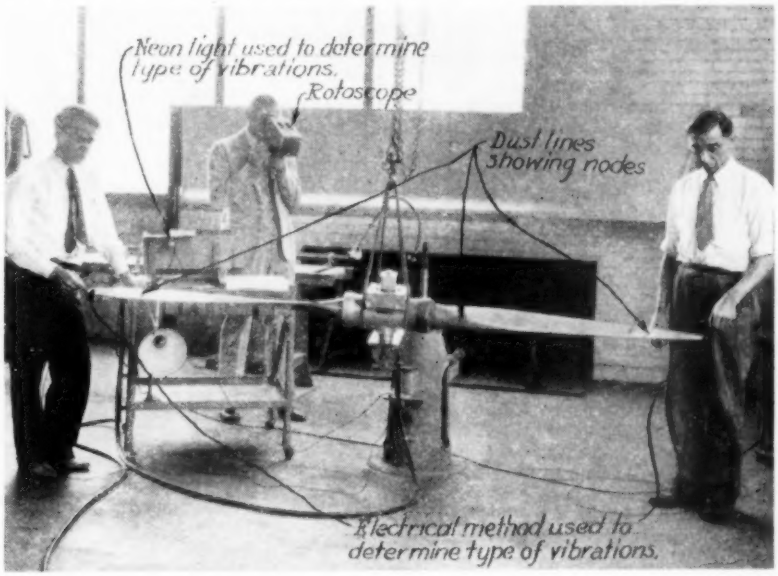
Testing Propeller Blades

by WALTER E. BURTON

(Photos by courtesy of Materiel Division, U.S. Army Air Corps)

PERFECTED methods for testing propeller vibration are now being employed by the Materiel Division of the U.S. Army Air Corps. This most important of all propeller research work, in view of the many accidents that have taken place with propellers is likely to revolutionize propeller practice.

For a full understanding of stress and vibration with propellers we refer you to Mr. J. D. Van Vliet's article in this issue.


Neon light used to determine type of vibrations.
Rotoscope
Dust lines showing nodes
Electrical method used to determine type of vibrations.

This electrical apparatus indicates whether both blades move upwards at the same instant or whether one blade moves up at the same time that the other moves down.

DANCING grains of sand are helping U. S. Army Air Corps engineers to solve perplexing puzzles about airplane propeller failure. The "sand test" is but one of several methods employed in the laboratories of the Materiel Division of the Air Corps, Dayton, Ohio, to reveal the manner in which metal propellers vibrate during operation.

The research on propeller vibration—which is not yet completed, but which already has yielded valuable information—was inspired by a considerable number of mysterious propeller failures on both commercial and military airplanes. For example, a pilot would be flying serenely along, when suddenly the tip of one of the plane's propeller blades would shoot off into space with disturbing effects on the engine and other parts. No one could explain satisfactorily why propeller tips would take such sudden leaves of absence.

In practically every case, the failing propeller, according to all engineers' calculations and tests, should have withstood much more severe stresses than those known to be present. For example, an aluminum alloy propeller might have, in the language of engineers, a limit of endurance of 10,000 lbs. per square inch. But it had broken when the operating stresses totaled not much more than a third of this figure! Or a steel propeller with an announced endurance limit of 60,000 lbs. per square inch might make its designers look like liars by failing when the stresses imposed by operating conditions were only 30,000 lbs.

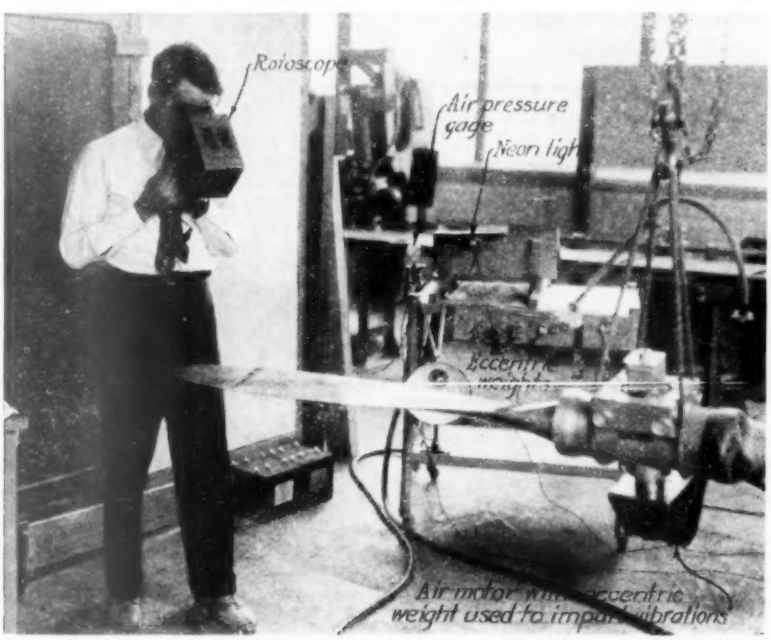
Evidently, the ordinary forces that tend to work hardships on metal propellers in service were not to blame. So it was decided that vibration must have something to do with the mystery. No one knew very much about the effects of vibration on airplane propellers. Here was a field virtually unexplored.

So, Lieut. H. H. Couch, Air Corps engineer, set up, in an engineering laboratory at Wright Field, equipment for making propellers perform various kinds of dances—for making them vibrate in practically the same way they are believed to vibrate in actual service.

Imagine yourself walking into Lieut. Couch's laboratory when he is performing some of his most entertaining tests. You notice at once something that reminds you of a child's swing. The "ropes" are lengths of shock cord, elastic rubber cable of the kind employed for absorbing shock in some types of airplane landing-gear; and the "seat" is a metal propeller perhaps 10 feet long. The shock cords are looped around the propeller near the hub so that they act as a vibration-proof support for it.

Hanging below the hub, at a point about where the engine shaft would be if the propeller were mounted for service, is a small air-motor with an off-center weight attached to its shaft. A hose extends from the motor to a control table nearby.

Lieut. Couch turns the handle of an



Another method of producing the vibrations—by compressed air.

air valve on the control table. The eccentric weight on the air-motor shaft leaps into action. The propeller blade is seen to quiver a bit. More air is admitted, and the motor picks up speed. Suddenly the tips of the propeller blade begin to vibrate up and down visibly, violently. A low hum, something like a musical note, comes from the propeller. More air is admitted.

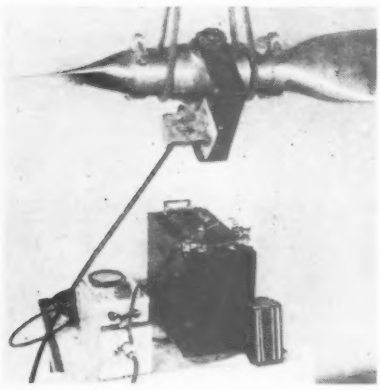
Suddenly, the tone changes to one of higher pitch, and the propeller is seen to change the tempo of its dance. You can see that the propeller is vibrating, particularly at the tips. Lieut. Couch picks up a large "salt shaker" and sprinkles sand over one of the vibrating blades. The sand dances around over the surface. Some of it falls to the floor; but some also collects in narrow bands across the blade.

"Those places, where the sand is collecting, are the nodes," the Lieutenant explains. "The metal is stationary there, but it is vibrating rapidly on each side of the band. When the portion of the blade on one side of the node is moving upward, that on the other side is moving downward. The section of a vibrating blade between two nodes is known as a loop."

When the propeller first started vibrating, there was one node in each blade. The frequency of vibration, determined by the number of times each second that the off-center weight made a revolution about the air-motor shaft, was comparatively low. As the vibration frequency was increased, the propeller suddenly changed its actions, and two nodes appeared in each blade. By increasing the frequency, Lieut. Couch has been able to produce three, four, five and even more nodes in each blade. These nodes are indicated by the sand test. Instead of sand, wood dust can be used.

"If I only could see just how the propeller is behaving . . ." you exclaim.

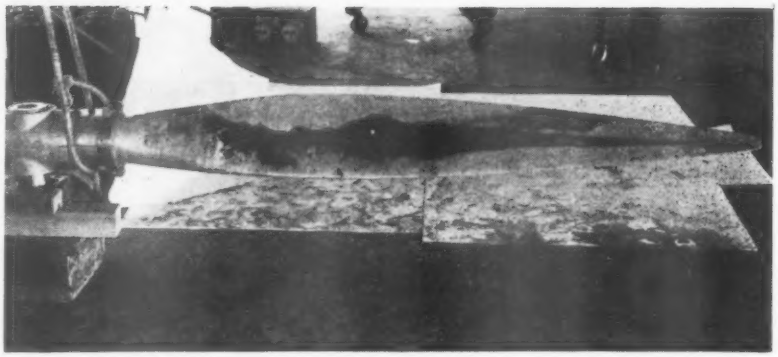
Very well, here is a laboratory gadget that will help you; a rotoscope. It reminds you of the old-fashioned parlor stereoscope. Box-like in form, it has a pair of eyepieces near the top, and a handle, with a crank at its tip to wind the spring of the mechanism inside, extending from the bottom. You look through the instrument at the vibrating propeller.



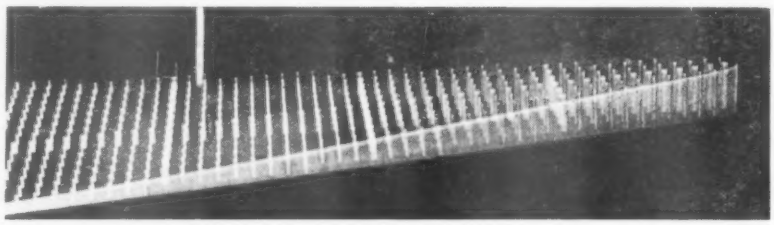
Vibration study of propeller vibrator with reciprocating weight.

It no longer is shimmying madly, but is doing a slow, graceful Oriental dance —behaving much like the arms of an Egyptian entertainer. The rotoscope, by making visible only certain vibrations, has slowed down the motion of the propeller so that you can study the action of the blades with ease. You see the stationary areas plainly, and between them the rapidly undulating sections.

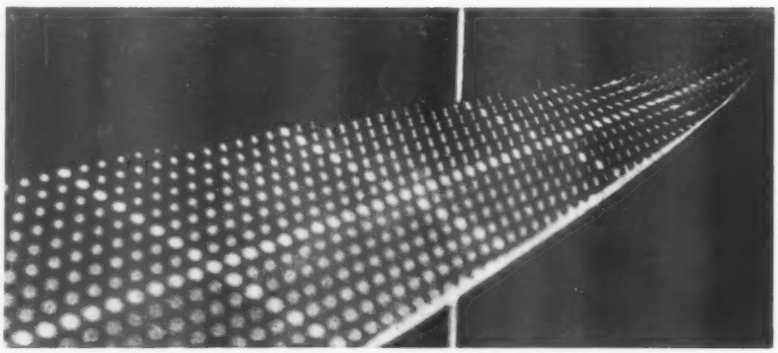
With this instrument, which is a type of stroboscope, the exact frequency of the vibration can be determined. The speed of the rotoscope shutter that whirls in front of your eyes is set so that it is somewhat greater than that of the weight on the air-motor shaft. Then the speed is decreased gradually until the weight appears to stand still. The frequency of vibration is then known, because the speed of the rotating shutter in the instrument is known.



Vibration study of a propeller in which the 5th node vibration period is at 12,000 v.p.m. This indicates the torsional vibration that tends to twist blade loose at hub.



Showing amplitude direction with respect to face side of blade.



The node, or point where failure is likely to take place is shown by the dots nearest the tip with the least amount of elongation.

By attaching the rotating weight in different ways, and by employing reciprocating weights, which move back and forth like the pistons in an airplane engine, Lieut. Couch has been able to produce a considerable variety of vibrations. But they all can be boiled down to three general classes: 1—Those with a node at the center line of the propeller hub. 2—Those with a loop at the center line of the hub. 3—A torsional vibration, where there is a single node extending along the blade from the hub towards the tip.

The third type requires a very high frequency to produce it. In fact, very few of our present-day engines produce a high enough engine explosion frequency to excite this type of vibration. While no actual failures can be attributed to torsional vibration, there is evidence in one case of a torsional type of vibration damaging the gearing used in changing the blade angle of a controllable-pitch propeller.

(Continued on page 260)

High-Lights and Side-Lights

by M. A. RODDY

Pertinent remarks concerning current happenings in aviation and the doings of the great and near great in this promising field of endeavor.

FEDERAL AVIATION REPORT: Chairman Clark Howell presented his Federal Aviation Commission report to President Roosevelt who sent it to Congress with the emphatic statement that he did not concur with the recommendation of the Commission that a separate aviation commission be created.

This decision of the President is a marked victory for the airline pilots who favor Interstate Commerce Commission control . . . Prior to President Roosevelt's message to Congress relative to the Howell report, Federal Transportation Co-ordinator Joseph B. Eastman appeared before Congress and proposed an expansion of the Interstate Commerce Commission and placing of all forms of transportation under strict and impartial Interstate Commerce Commission regulation . . . A program which has the President's backing.

As indicated some time ago in this column, airline operators will probably receive an increase in their rate payments as the Interstate Commerce Commission will be empowered to lower or RAISE mail payments . . . According to President Roosevelt, government aid is necessary in order to save companies from disastrous loss but not in order to provide unreasonable profits, which seems to be a bit opposite of the views of Postmaster Farley who introduced "bargain" rates pending permanent air-mail legislation.

Speaking of the Postmaster, genial Jim continues to have his troubles especially concerning the "$12,000,000 surplus" which he claims for the Post Office Department . . . It is said that Mr. Farley is reported to be slated for the movie job of Will Hays who was a former Postmaster, too . . . Senator Norris of Nebraska has introduced a bill which would force Farley from his present Cabinet position were he to continue as chairman of the Democratic National Committee.

Oh yes, the Federal Aviation Commission spent $65,000 to compile its 254-page report which was the 20th investigation of the air industry . . . 21st is on the fire.

EARHART: 'Tis whispered very loudly that Amelia Earhart's great solo flight from Honolulu to Oakland was a publicity stunt for which the feminine air queen received ten thousand pineapples (Hawaiian for dollars) . . . said flight was engineered by the Pan-Pacific Press Bureau, which is affiliated with the advertising agency of Bowman, Dente, Cummings, Inc., of California.

Seems that the Hawaiian Sugar Planters' Association contracted with the Bowman firm for an "educational" campaign to change public opinion in the United States, as since the passage of the Jones-Costigan Act, domestic sugar quotas and territorial possession quotas are limited under the AAA . . . $125,000 was appropriated for the propaganda program with Amelia's flight as the grand climax.

The nose of the ship peeks over the clouds to glimpse the winding river below. This is a scene familiar to all pilots of airliners.

It won't be long now before air-mail pilots are winging their way daily across the Pacific . . . They will be lucky if they get $10,000 a year.

However, the fact remains that Amelia did a good job and deserves a big hand . . . After a trying trip of eighteen hours over the rain- and wind-whipped Pacific she landed very tired at Oakland airport and when a burly police officer attempted to push away reporters who were pleading the necessity of making a deadline, Amelia interfered and told the policeman that deadlines were important affairs and she very graciously gave an interview.

I know a certain Colonel who could learn quite a bit from that little incident . . . but, he never will.

AIR DERBIES: None other than the NRA general, Hugh S. Johnson, and Elliott Roosevelt are SPONSORING a proposed 18,000-mile international air race around South America and return . . . Yes sir, they are SPONSORING it but it is reported that Edsel Ford and Philip Wrigley are BACKING the race, which will be open to non-military planes of any nation . . . Wonder if Elliott has figured it out the way I do that on paper the new deal for aviation calling for a commission to have absolute authority over the air industry leaves his friend Eugene Vidal right behind the eight ball, unless . . .

William Templeton, manager of the Vancouver, B. C., airport, is planning for next summer a 3,000-mile international air race across Canada with a pot of gold for the winner.

Professor Piccard, who four years ago was the first person to take a balloon into the stratosphere, expects to ascend twenty miles above the earth in a new balloon now under construction which will take him up 105,000 feet from which altitude he will be the first man to see the earth as a globe . . .The Goodyear Tire & Rubber Company has been awarded the contract to build a 3,700,000-cubic foot bag, the largest ever constructed, for the 1935 stratosphere flight of the National Geographic Society and Army Air Corps.

WAIT UNTIL THE W. C.T.U. HEARS ABOUT THIS: Dr. Ernst Gelhorn and Irwin G. Spiesman of the University of Illinois conducting experiments in the interests of aviation have proved that one may get drunk on air . . . According to the tests normal persons who breathed air with half the usual oxygen content insisted 4 times 4 did not make sixteen and and became angry at those who disagr . . . Maybe that is why we have so many parachute jumpers . . . that air must be good until the LAST DROP!

Here's one Al Williams discovered . . . It's a whistle contest when you are flying on one of the high-riding airliners . . . Try and whistle the scale . . . It just can't be done . . . air's too thin.

Charlie Blake, star reporter for the Chicago American, tells me that while Dr. Allan (Quintuplets) Dafoe was en route from New York to Washington on his FIRST airplane ride he leaned over and inquired if the venerable country doctor was nervous.

"No, why should I be?" replied the doctor.

"That's right," said Charlie who

realized that if the arrival of five world-famous Dionne babes failed to excite the rural physician, no airplane was ever going to throw him.

BOTTOMS UP! When Major James H. Doolittle recently made his record-breaking flight from Burbank, Calif., to Floyd Bennett airport, N. Y., in 11 hours and 59 minutes, he continued on to Newark, N. J., where a few minutes later he was greeted by Mayor Meyer C. Ellenstein to whom he gave three oranges he had aboard his plane.

The Jersey mayor ate one before he discovered a note in the package telling him that the fruit was for Mayor La Guardia of N. Y. . . . Abashed, Mayor Ellenstein wrote to Mayor La Guardia offering to share the remaining two oranges . . . La Guardia accepted the invitation suggesting that orange juice mixed with gin makes a delightful drink and adding that fortunately the oranges were green but no doubt would have ripened traveling between Newark and New York, a sally prompted by the rivalry between Newark Airport and Floyd Bennett Field for honors as the eastern air terminus.

I know what the Governor of North Carolina said to the Governor of South Carolina, but so far I do not know what the answer of Mayor Ellenstein was to my friend in New York.

It must be May 1 in the Antarctic regions as the folks are all getting ready to move . . . Mrs. Richard E. Byrd has started for New Zealand where she will soon meet her distinguished husband when he returns from the frozen wastes of Little America . . . Lincoln Ellsworth has started home because exceptionally bad weather in the Antarctic prevents further flying.

George Page, chief engineer of the Curtiss-Wright Airplane Company, announces the construction of a new giant Condor transport plane which can transport an automobile in its fuselage, carry 16 soldiers with packs and be arranged to serve as an ambulance, carry general freight or other supplies.

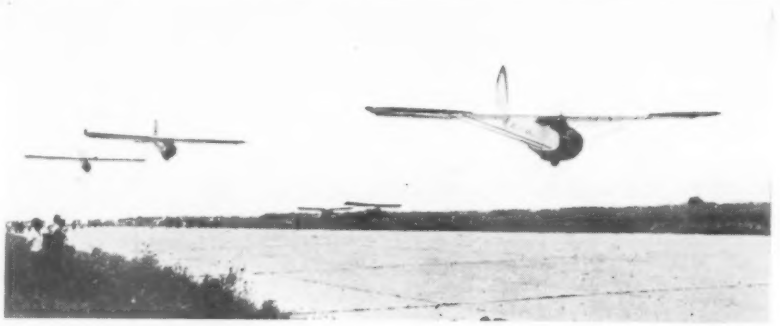
HANGAR FLYING: Dave Behncke continues favorably on the road to recovery at Holy Cross hospital, Chicago . . . Solicitor Crowley states that Braniff Airways have declared their intention to pay pilots according to the National Labor Board scale . . . the company will also purchase $400,000 worth of new equipment . . . Harold Crary has been appointed vice president in charge of traffic and advertising for United Air Lines . . . Air Express tonnage for 1934 increased 115% as compared with the previous year.

The Bureau of Air Commerce reports that there are now 2,297 airports and landing fields, 664 of which have either partial or full night lights . . . 13,949 pilots and 6,339 aircraft holding active licenses . . . A special great circle chart has just been completed by the Geodetic survey for the benefit of racing pilots on long-distance flights.

Col. Roscoe Turner is planning among

(*Concluded on page* 260)

Toot—Toot! Here Comes the Sky-Train!



Here is the Sky-Train made up of a series of gliders towed by an airplane. This may eventually solve the problem of local deliveries by air.

AIR transportation in the future may be patterned after the railroad locomotive with its string of cars, if experiments now underway at Floyd Bennett Field, N. Y., meet the expectations of those conducting them. A number of cross-country test flights have already been made and the results are promising.

In these tests one powered plane, the "locomotive," was used, behind which were strung out in tandem three gliders. The gliders were attached one to the other by means of cables, which could be reeled into the two forward gliders, or airplane, when the craft behind released it. A compact 7-watt, 25-pound radio was carried in each glider and constant communication was maintained with the pilot of the airplane during the trial flights.

Recently, a cross-country trip was made from New York City to Washington, D. C., and gliders carrying mail, for the first time in history, dropped off at Philadelphia, Baltimore, and Washington. In the latter city, the glider landed almost on the back lawn of the White House, in a space far too small for any airplane to operate out of. Each glider carried 4,000 letters. The gliders were Franklin Utility machines and the towing plane was an Eaglerock.

On this flight, the sky-train met exceptionally rough weather and although a landing was made simply as a safety precaution, it demonstrated that the train can stay aloft in highly turbulent air.

The obvious advantage of the sky train is that much greater weights can be carried than can a single airplane. Each glider is supporting its own load and is depending upon the "locomotive" only to pull it forward and not to lift it. On the other hand, the gliders of course slow up the plane somewhat, but only to a negligible extent. It is estimated that the speed of the plane is decreased but 3.5 miles per hour for each glider attached.

The sky-train, it is believed, would be of particular value in landing mail at small towns without airports along an airline.

There are certain disadvantages to the system however. Extra pilots are of course required to man each glider, and once the glider has landed it must stay down until towed back into the air. Moreover, as constructed today, gliders are not built to stand the stress of high speeds. Nor can they carry heavy loads. These problems will of course have to be solved before the project reaches a practical stage.

2-Cycle Simplicity Appeals to Amateur

RECENTLY, there has been a revival of interest in the 2-stroke-cycle engine, more commonly known as the 2-cycle type, and this revival has undoubtedly been due to an increasing interest in lightplanes.

In the first place, a 2-cycle cylinder gives twice as many power impulses per revolution as the more common 4-cycle type, hence for the same smoothness of running and power, the 2-cycle engine requires only half as many cylinders, pistons, connecting rods, etc., as the prevailing 4-stroke models. This is a mighty advantage within itself for a simple low-priced lightplane engine.

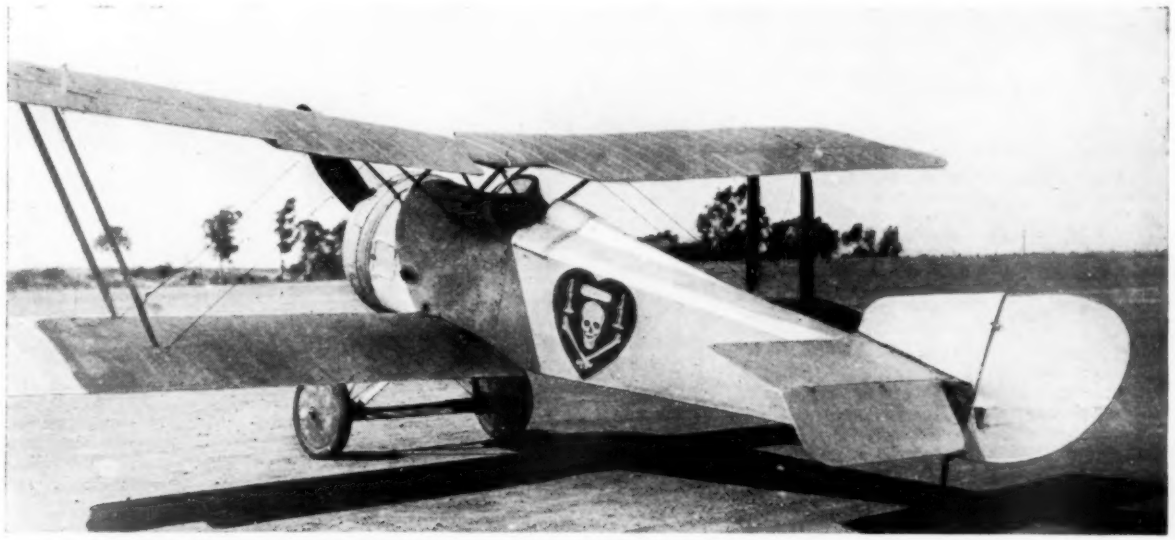
But there have been many obstacles in the way of 2-cycle development. The many 2-cycle engines placed on the market in the past did not perform according to the fond expectations of their builders. They wasted fuel, were hard to start and did not develop twice the power of the 4-stroke engine as anticipated. Then, since crankcase compression was employed with the great majority of the 2-strokes, there was a great deal of trouble from this source, such as the contamination of lubricating oil, etc.

In the next issue of POPULAR AVIATION will be an authoritative article on this subject by the aviation engine authority, Glenn D. Angle. He will discuss the 2-cycle problem from the standpoint of the lightplane builder and owner.

Nungesser's Hanriot in U.S.A.

by FRED L. WESTLAKE

Not many genuine old wartime planes exist in the United States, particularly ships that are in flying condition, but the Nungesser plane is still in excellent shape and is still flyable.



This Hanriot biplane is the original plane used in combat by Captain Charles Nungesser of the French Air Service and bears the original insignia used by the French ace during the war. It is now located in California.

THERE are very few authentic wartime crates left in this country that are in flying condition. Jimmy Granger, Clover Field, Santa Monica, California, however is the proud owner of a plane used in actual combat by Captain Charles Nungesser of the French Air Service.

When Nungesser was in California, he made Clover Field his headquarters and the mechanics at this field did most of his repair work. When Nungesser made his ill-fated attempt to fly from France to America, he left his war plane with Jim Granger.

Finally, when all hope of ever finding the well-known French flyer was given up, Mrs. Nungesser presented the Hanriot to Mr. Granger as a tribute of friendship between the two men. The new owner has kept the plane in condition and has flown it many times.

For a while it was on exhibition but the vicious souvenir hunters become so obnoxious that the plane had to be put in a roped-off area in the hangar. It may still be seen if Mr. Granger can be assured that you will not tear fabric off the wings or steal the prop.

If other owners of wartime ships were as careful of their planes, we would still have a good many of these interesting relics of pioneer war flying. Unfortunately, most of the ships of this type belonging to private owners have been allowed to deteriorate until they are mere tattered skeletons. A good many have been cracked-up or completely "washed-out" while being flown for motion picture work.

An outstanding example of the latter is furnished by the Gotha that was used so effectively in a number of war pictures. The plane was not deliberately cracked-up as is sometimes the case. But one day, while doing aerial maneuvers for a war movie shot, the plane was thrown into a spin. The pilot, failing to bring her out of it, took to his chute while the mechanic for some unknown reason failed to bail out and was killed.

The plane, of course, was a complete "washout." I mention this merely to indicate one of the reasons why war service planes of 1914 are all but extinct with the exception of those in the museums. The next fad for war movies will probably finish up the few that are left.

The Nungesser plane is of particular interest because he is perhaps the best known French ace in America. It is true, that Rene Fonck with seventy-five German planes to his credit, and George Guynemer with fifty-three accredited victories, outrank him as an ace, for Nungesser brought down but forty-five Hun ships.

Captain Nungesser, however, had more personal contact with Americans due to his tour in America. His pleasing personality and lecture appearances contributed to his popularity in the United States. Added to this, of course, was his spectacular martyrdom as a victim of the exceedingly hazardous East-West flight across the Atlantic.

In spite of the fact that the Clover Field hangars house modern commercial planes, trim racers and a freak flying gadget called the "Whatsit," which everyone has seen in the newsreels, the Nungesser relic is easily the most interesting ship in the hangars.

The ensignia on the fuselage is unusual enough to attract immediate attention. According to the story, the Huns placed a bounty of fifty thousand dollars on Nungesser's head. The French ace responded by painting a coffin and candles on his ship. The coffin was a flaunting challenge to put him in it if they could. Later the skull was added.

Every time Nungesser suffered a head injury as the result of a crack-up he added a line or two in accordance with the markings shown on the X-ray pictures. Later, when the intrepid flyer injured his legs, the shinbones were added to the skull decoration. The fractures shown on the X-ray were also duplicated on the shinbone ensignia.

In this manner, the Heines were supposed to know just what progress they were making toward putting the Frenchman in the casket. Nungesser is probably the only allied aviator that kept such an emblematic and ironic score card for the benefit of the enemy, or perhaps he intended it for a personal diary. The significant part of the whole thing is that, while this was

going on, he was constantly bringing down enemy planes.

Nungesser had some twenty crack-ups in all. The word suino (swine) is written on both sides of the fuselage. This was his greeting to the enemy. It's quite evident that he didn't like the Bosche flyers any more than they liked him.

This ship was flown by the owner, Jim Granger, during the filming of "Hell's Angels." Incidentally Mr. Granger had a rather nerve-racking experience while flying this ship. One day, as he was flying over Hollywood, the Gnome Monosoupape motor on the Hanriot, for no reason at all, conked out. Granger pulled everything on the dash in a frantic effort to revive the dead powerplant but without success.

Of course, this type of ship loses altitude very fast with a dead prop and he was just about to plunge into a reservoir when the motor suddenly took hold and saved him from a very wet forced landing which would probably have been the end of another wartime relic as well as Mr. Granger.

However, Mr. Granger usually flies with a 'chute when piloting this ship. He doesn't distrust the Hanriot, but it's just in case! Those who have had experience with the single-valve type of engine of the war era, no doubt understand and agree with the owner's foresight.

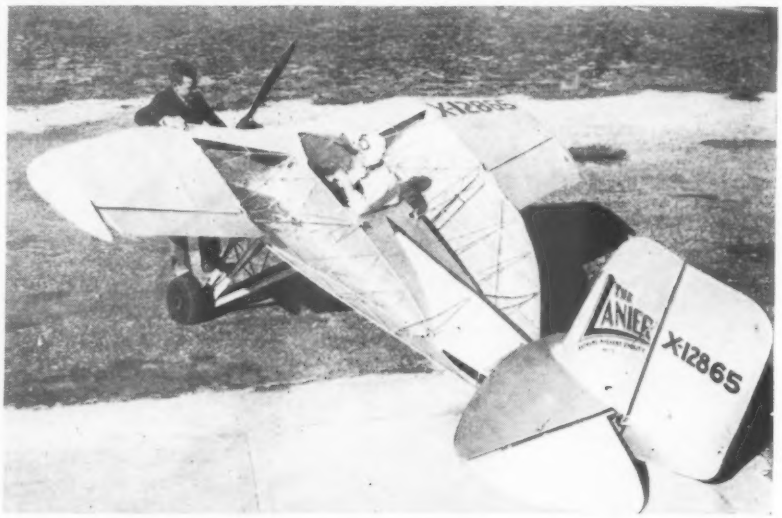
An interesting feature of this plane is the unusually small tail assembly. Mr. Granger informed me that one aviator, after a brief try-out, refused to fly the Hanriot because he insisted that the small area of the tail surfaces made the plane cranky. The owner, however, has experienced no particular difficulty in flying this pioneer crate which has survived the "dog-fights" of the World War and the sometimes equally hazardous sham battles of Hollywood.

Captain Nungesser managed very well in spite of the abbreviated tail surfaces, for ten of his forty-five victories were scored with this ship. The size of the rudder was of interest to me because I know that imitation Fokkers are sometimes made for motion picture purposes by enlarging the tail assembly of an ordinary Travelair. A Hisso motor and a few changes in the cowling do the rest. The result is an obvious fake that is quite readily detected by any aviator who has a knowledge of the two types of planes, but the general public is none the wiser.

A knowledge of some of the fakes put over in pictures, however, adds to the interest in knowing that occasionally real war planes are used.

Very clever reproductions have been made from time to time by the producers of war films and the construction of such ships has reached a fine point. Two Spads, recently rebuilt from "Tommies" are the last thing in accurate faking. So far as interest goes, little is actually lost by the use of faked planes.

The Latest Lanier Vacuplane Successful



The Lanier Vacuplane showing the peculiar chambers between the wings and body that produce lift.

FROM TIME to time, POPULAR AVIATION has published data on the development of the Lanier Vacuplane during the course of its development, and we are now in possession of data on the latest of these ships tested at Troy, N. Y.

This development, by Edward H. Lanier, began in 1908 in Cincinnati, Ohio This was a monoplane with an open concave cell in the center section. Later, three other models were built and flown. The present Vacuplane gives satisfactory take-off and climb and is exceptionally stable in flight. It is driven by a 36 h.p. Aeronca engine.

It is claimed that the Vacuplane does not slip nor dive in a stall and that the concave cell acts as a parachute when it is settling down.

Airworthiness Requirements Questioned

THIS protest, from a prominent aeronautical engineer was received at our office. It is representative of several on the same subject.

DEPARTMENT of Commerce Officials. Under your present policy of changing the airworthiness requirements every two weeks, how is it possible for one ever to complete an analysis for approval—or is it part of your plan that no one is to be able to do so?

In order to show the reason for these questions, let us for the moment review the events of the past year in regard to the airworthiness requirements. Until that time it had been the custom for changes in the requirements to go into effect on January 1 of each year, with advance copies of the new bulletin ready by the first of October. That happened in the fall of 1933 as usual, and while the requirements were drastically changed, the industry felt that the change was a step in the right direction, and adapted itself to the new requirements. Late last March came another revised bulletin, containing several minor changes, which was to be effective on July 1. A meeting of the manufacturers was called for late in May to discuss the changes. As a result of the meeting, several more minor changes were made, and the date of effectiveness set forward a month.

Before that date, still more changes were made, and the date set forward, again. In August a memorandum was sent out which announced that the new requirements would go into effect on October 1, with nothing said about changes of major importance.

That was the end of the story, until about November 1, when the requirements which had become effective a month earlier were finally released. It is easy to imagine the feelings of the industry, when it was found that in these new requirements the definitions of the basic load conditions, and consequently the entire procedure in an analysis.

As if that had not been enough, the industry then had to wait two weeks more until Bulletin 26, the companion to the requirements, was released.

That seemed to be the end of the changes, and the industry tried to adjust itself to the lost six weeks, and get started over again.

But you, Department officials, did not seem satisfied even then. On November 24, ten days after Bulletin 26 had finally been distributed, you issued a memorandum revising it. You issued the memorandum under that date, yes, but you did not send the memoran-

(*Concluded on page* 262)

Landing in Your Back Yard

by JUAN de la CIERVA

An article by the inventor of the Autogiro which predicts the future development and use of the "flying Windmill." Will the autogiro ever take the place of the conventional airplane?

THE appearance of the latest type of autogiro probably marks the biggest step forward in the history of flying since the day when the brothers Wright built their first experimental machine. It is in fact safe to prophesy that this invention is destined to revolutionize the future of aviation in this and other countries.

Despite its many remarkable achievements the average man has up 'til now been inclined to regard the autogiro as something in the nature of a mechanical freak, whilst many famous pilots would no more have dreamed of taking the controls of this latest product of aeronautical research than a crack jockey would think of riding a carthorse in a Derby.

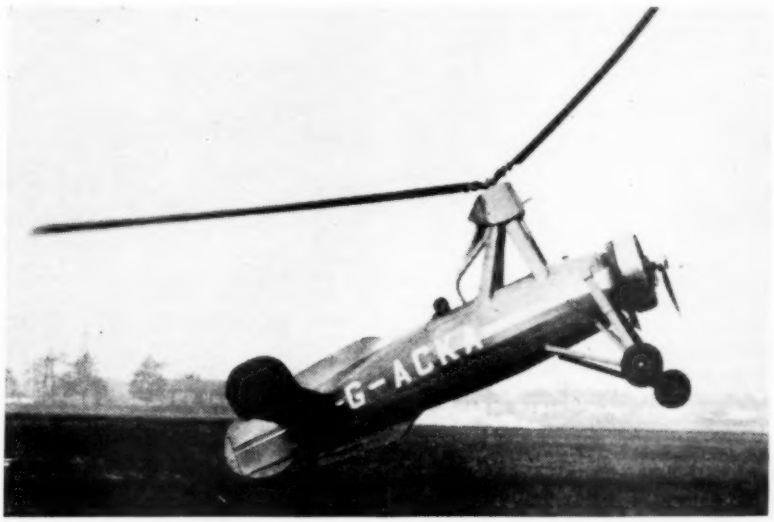
But it is as well to remember that the autogiro is really only ten years old, for although the first machine with freely rotating blades round a vertical axis was tried out in 1920, the finished product did not take the air 'til 1923, and the first British-built machine made its appearance at the Hendon Air Pageant in 1926.

Since then, each model produced has been a step nearer to the ideal of the flying machine which would be as easy to operate as a motor car. During the past few years the autogiro has proved its reliability in many long flights. In April, 1931, Miss Amelia Earhart ascended to a height of 18,400 feet, thus amply disproving the criticism that the ceiling of the autogiro is too low. In the autumn of 1930 I flew one myself through France and Spain for about 200 flying hours, in the course of which I made some 300 landings, one of which was on the lawn of the Santander Golf Course—an area of only 50 yards in length. Imagine an airplane attempting to land on such a confined space. A fatal crash would be inevitable.

Many a one-time "hearsay" critic of the autogiro has been completely converted, almost involuntarily after his first flight, and a typical "recantation" of one very well-known pilot puts the case in a nutshell—"When flying my own machine my safety is 90 percent myself and 10 percent machine; when flying the autogiro my safety becomes 90 percent machine and 10 percent myself."

Safety, and to a lesser degree simplicity and cheapness, that is the real purpose of the autogiro—a question which has often been put to me, even by personal friends.

The whole idea has been to produce a flying machine which, unlike the airplane, will not depend upon any high degree of forward speed for lift stability and control. Once this has been achieved, safety of air travel is immeasurably increased, for it is common knowledge that the great majority of airplane crashes are due either to failure to maintain the high forward speed necessary to keep the machine in the air, or to misjudgments in taking off or landing, which also necessitate a high minimum speed, the loss of which involves a stall or a spin. Already statistics have proved the autogiro to be at least ten times safer than the airplane.



One of the latest examples of the Autogiro with direct control and without the wing formerly used.

For, contrary to popular belief, the autogiro has never been just an airplane "with something on top." Even in the earliest models the risk of a stall—that ever-present bugbear of the pilot—had been practically eliminated. But until this year what amounts to vertical ascent and descent were still to seek; it was impossible to fly at under 25 m.p.h. without losing altitude; and control still depended upon a degree of forward speed.

To the uninitiated, the great difference between the latest model of autogiro and previous types appears to lie in the absence of wings and rudder. This, however, is illusory and quite superficial, for the small fixed wings in the earlier type were of little more intrinsic value to the machine than were the rudimentary toes of the prehistoric horse. They would have been of little or no use in planing down to a landing in the event of a break-down of the rotor or the snapping of one of the blades.

The essential difference between the old type of autogiro and the new, which constitutes its great advantage, lies in the new type of control which makes it entirely independent of forward speed. This control consists in tilting the rotor either way at the will of the pilot. The axes being connected with the joy-stick, which, unlike the airplane control, is of the "hanging" type and comes down from above where it connects with the rotor hub.

In plain figures this means that this new type of autogiro can fly level at approximately 12 m.p.h., can descend quite vertically and take off in under ten yards in normal conditions! There is no apparent limit to the size, type or capabilities of future models. The latest machine is small and of comparatively small power, but there are autogiros in existence which can attain a top speed of 120 m.p.h., with a cruising speed of 100 m.p.h. and can take a normal load of about 1,700 lbs.—figures which compare favorably with the performance of any light airplane of similar class.

And it may come as a surprise, to any who may still be inclined to regard the autogiro as a kind of aerial perambulator, to learn, that although the machine is quite definitely not designed for stunting, although I fail to see that any useful purpose is served by displays of "aerobatics," it can be made to loop-the-loop with ease and safety. The blades of the rotor, when

(Concluded on page 268)

A Long Distance Air-Photo

THIS aerial photograph of Mt. Shasta, California, was taken from a distance of 331.2 miles at an altitude of 23,000 feet and is the longest-range photograph ever obtained. This constitutes the greatest amount of the earth's surface ever covered in one exposure.

The photo was made from a position 100 miles further south than the last point from which Mt. Shasta was visible to the unaided eye, and the camera had to be carefully "aimed" by using the flight map and checking on recognizable landmarks to insure focusing the lens in the correct direction.

When the picture was taken, the Bay region was wreathed in fog and smoke, hindering the visibility of the human eye but not that of the specially constructed camera, worth many thousands of dollars. The film used, technically known as Kryptocyanine, hypersensitized, is similar to that supplied to astronomers for photographing stars.

The picture was taken by Captain Albert W. Stevens of the Army Air Corps from an F-1-A monoplane, one of the fourteen photographic planes of this type owned by the army. If the earth were flat, the area visible in the photograph would be 26,000 square miles, but due to the fact that the earth curves the view is interrupted midway between Mt. Shasta and the camera. The terrain actually visible in the photograph is computed at 7,200 square miles.

A glimpse at the K-6 camera used for this work, in the accompanying photograph, shows the tremendous size of the lens required for the admission of all light possible. It is capable of collecting the faintest rays of light and transmitting them to the sensitized plate where the photographic record is made. It is mounted much after the manner of a machine gun on the rear cockpit coaming so that it can be quickly and accurately adjusted.

While it is not definitely stated that the infra-red light rays are depended upon for penetrating the mists and fogs, yet this is probably the case to judge from the nature of the plates used. It should be understood that mists and fogs present the greatest resistance to ordinary white light, but are much more easily penetrated by the lower frequency infra-red rays. White light or light at the blue end of the spectrum are quickly stopped by water vapor of any description while the deep oranges, reds and infra-red rays penetrate much further.

The color of light, or simply color, is due to the difference in frequency of the light waves. The ultra-violet rays on the blue end of the spectrum have the highest frequency or rate of vibration, then the violet, indigo, blue, greens, yellows, orange and reds following in decreasing order until we reach the lowest frequency in the infra-reds. This approaches the heat waves.

This is the long-shot, taken at 331.2 miles from camera.

Capt. Albert W. Stevens and the K-6 long distance camera.

Stresses in Propeller Blades

by J. D. VAN VLIET

A simple yet illuminative study into the stresses developed in airplane propeller blades during flight, the vibrations that attend the operation of the propeller and the materials employed.

THE designing of propellers is governed by two considerations, namely: the desired aerodynamic performance, and the strength requirements. If a satisfactory solution of its operating problems conflicts with the requirements of strength and rigidity, a compromise must be effected by which both criteria are met. In this, as in other matters pertaining to the design of propellers, extensive experience and judgment are good guides and time-savers.

A propeller in operation is subjected to a combination of stresses attributable to three causes: the *air forces*, the *centrifugal forces*, and the *gyroscopic forces*.

At first flush, the problem appears simple enough, since the propeller blade represents a cantilever beam carrying a load distributed along its entire length. The propeller blade however is of a screw-like or twisted conformation, varying in thickness and weight from root to tip, and having cross-sections which differ considerably in area and profile-contour all along the length of the blade, each cross-sectional element having its own values for lift, drag, and resultant airload.

The resultant air forces moreover do not lie in the same plane, but differ in direction, and with but few exceptions, they do not pass through the centers of gravity of the respective cross-sectional areas. The airload itself, by reason of the variations in the values of Kx and Ky coefficients for the different sections, and their increasing rotational speeds from root to tip, is not uniformly distributed along the blade.

This condition is schematically illustrated in Fig. 1, which for the sake of easier contemplation, shows a propeller placed horizontally and revolving in the direction indicated by the arrows. The dotted surfaces show some of the blade-sections and it is seen that they diminish in camber, thickness and area from the root of the blade to the tip, the angle of each blade-section being designated by a_1, a_2, etc. The points C_1, C_2, etc., denote the centers of gravity of the areas, and it has been assumed that all these centers lie in the radius O-X perpendicular to the axis of rotation R-R.

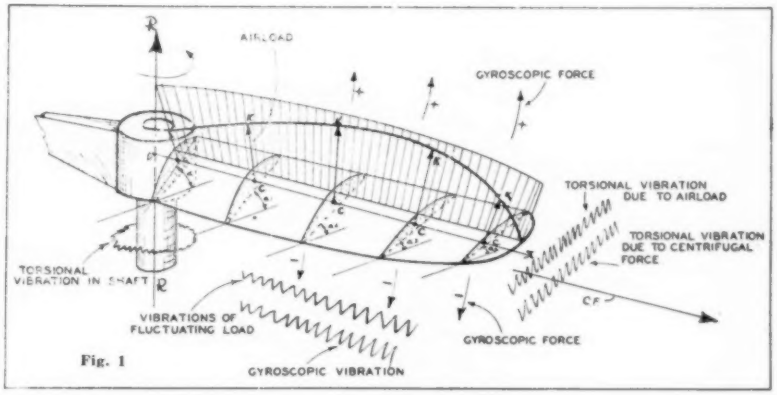


Fig. 1

The translational direction of the propeller is indicated by the arrow b.

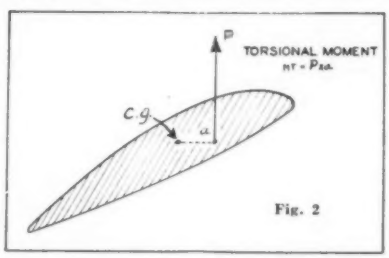


Fig. 2

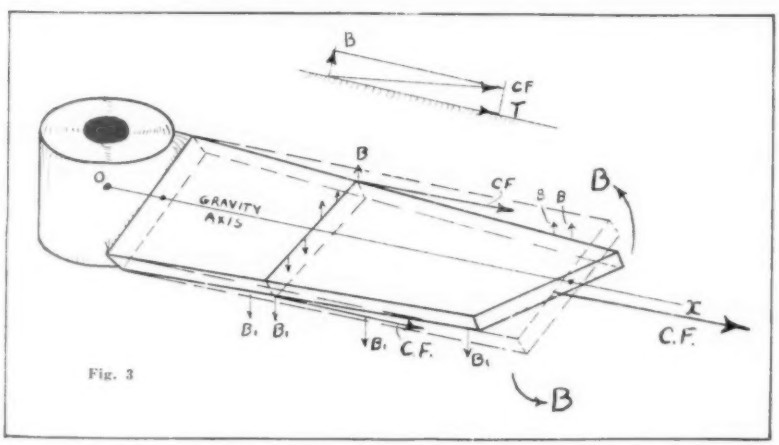


Fig. 3

The fringe formed by the combined aerodynamic resultants K for all cross-sectional elements of the blade is indicated by the vertically striped area, and it has been assumed that the points of intersection of the resultant air forces with the upper curves of the cross-sectional areas lie in a straight line substantially parallel to the radius O-X.

It is seen that this plane of resultant air forces is not flat, but *twisted*. The comparative magnitude of the resultants is indicated by the line h.h., and the darker shaded area enclosed by this line gives an idea of the actual distribution of the airload and of the varying directions in which it acts.

The airload subjects the blade to *bending stresses*, with their attendant *transverse* and *longitudinal shearing stresses*, the transverse shear being tangential to the cross-sections and the longitudinal or radial shear parallel to the neutral or gravity axis. Since the resultant air forces do not pass through the centers of gravity of the cross-sectional areas, but a little distance *forward* of those centers, they constitute twisting forces which produce torsional moments all along the blade, the torsional moment on each blade element being equal to the resultant air force on that element multiplied by the perpendicular distance from the center of gravity to the air force, as illustrated in Fig. 2, where the torsional moment is Pxa.

These torsional moments on the blade will tend to twist it upward, thereby increasing its angle of incidence and thus affecting its aerodynamic performance. It will also cause torsional shearing stresses in the blade.

The blade then will be subject to *bending vibrations* as well as *torsional vibrations*, which, if coinciding in period with that of the natural fre-

quency of the blade in bending or torsion, will give rise to *flutter*.

The tangential shear induced by torsion will increase the cross-sectional bending shear forward of the center-of-gravity axis O-X, and counteract or diminish the transverse shear back of the gravity axis.

In addition to the stresses induced by the airload, the blades, by virtue of their mass and rapid rotation, will also be subjected to stresses caused by *centrifugal forces*. The effect of these forces is complicated by the helicoidal twist of the blades. The centrifugal force tends to pull the particles of the blades away from the center of rotation, the force being exerted *in the plane of rotation*. Now in a propeller blade two corresponding points of any two consecutive sections hardly ever lie in the same plane of rotation.

When the propeller is designed in such manner that all the centers of gravity lie on a radius at right angles to the axis of rotation, i.e., in the same plane of rotation, all other lines connecting corresponding points will deviate from the axis O-X.

This is illustrated in Fig. 3, in which, for the sake of exemplification, the propeller blade is represented by a flat twisted board, the gravity axis O-X of which is at right angles to the axis of rotation. The dotted lines show the board as it would appear when flat, while the full lines show it in its twisted condition.

The rear edge R then is twisted upward at an angle i to the gravity axis, while the front edge is twisted downward to the extent of the angle j. The centrifugal forces CF then act in planes parallel to the plane of rotation of the gravity axis O-X. The result is that on an inclined surface, as shown in the insert in Fig. 3, the centrifugal force CF is resolved into two components: B, perpendicular to the surface, and T, parallel to the surface.

On the front—or entering edge of the propeller the forces B act in the direction of the air forces, whereas on the rear edge they act in an opposite direction, thus creating a torsional couple tending to twist the blade in the direction of the arrow. By reason of these components the centrifugal forces will thus constantly try to increase the helicoidal twist of the blade, while the components T will at the same time put every fiber of the blade in tension.

The torsional shearing stresses due to the centrifugal components B in the front portion of the blade will be added to the shearing stresses due to bending, whereas back of the gravity axis the components B^1 will counteract the shearing stresses. This pulling and twisting action of the centrifugal forces will contribute to the vibrations of the blades.

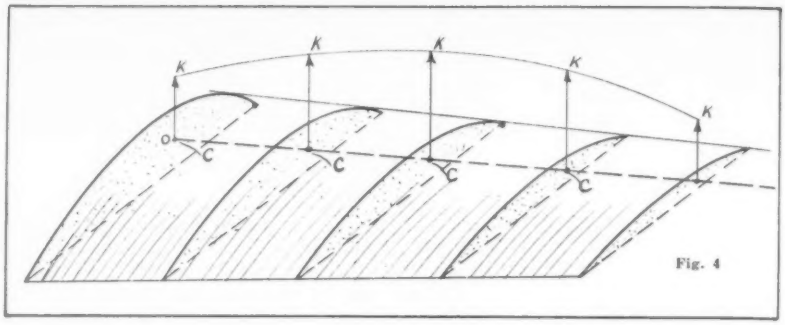


Fig. 4

Gyroscopic forces only occur when making turns and are usually of inconsiderable magnitude, unless a turn is made at a very small radius at a very high speed. They act as a couple on the propeller, being positive on one blade (i. e., acting in the direction of the air forces), and negative or opposed to that direction on the other blade. In a two-bladed propeller they alternate in direction twice in each revolution, so that when making a turn this rapid reversal of stresses will cause a very marked vibration.

The stresses caused by gyroscopic forces are, of course, bending stresses, which are alternately added to or subtracted from the bending stresses due to the air forces. This condition is illustrated in Fig. 1 where the gyroscopic forces G are marked (+) when acting in the direction of the air forces, while the alternate forces G^1 are shown as acting in the opposite direction and marked (—).

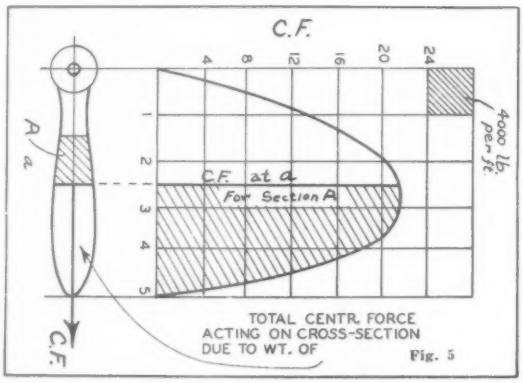


Fig. 5

The propeller shaft of the engine is subject to torsion by reason of the torque of the propeller, and it has accordingly an inherent period of torsional vibration. When the number of rotational impulses imparted by the engine to the propeller at a certain number of revolutions per second, coincides with the natural frequency in torsion of the propeller shaft, the shaft will vibrate violently, and the particular speed at which this takes place is said to be its *critical speed*.

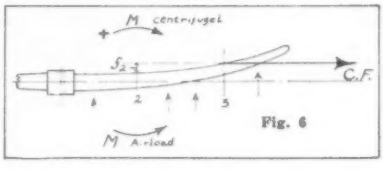


Fig. 6

This vibration will then be communicated to the propeller and if the frequency of this vibration should harmonize with the torsional and bending frequency of the blades, the propeller will vibrate excessively. If this contingency has been disregarded by designing the blades in accordance with the elastic limit of the material instead of with the fatigue stress, failure of the blades will eventually occur through the fatigue or internal break-up of the material.

Recapitulating, we find that the propeller has to cope with the following conditions:

1. *Resultant air forces*, causing bending stresses, cross-sectional shearing stresses, radial shearing stresses and torsional shearing stresses. Also vibrations due to bending and torsion.
2. *Centrifugal forces* causing tensile stresses and torsional stresses and vibrations.
3. *Gyroscopic forces* causing alternating bending stresses, with attendant alternating cross-sectional and radial shearing stresses. Also bending vibrations.
4. *Critical rotary speed*, causing excessive torsional vibrations in the propeller shaft and attendant rotational vibrations in the propeller blades.

From the above it is evident that calculating the strength of a propeller is by no means an easy matter, and thus far no truly accurate method has been devised.

An approximate method, however, has been worked out in which the problem is considerably simplified by introducing certain assumptions and by making due allowance for the probable inaccuracy caused thereby. It is beyond the scope of this article to give a complete numerical example, and we shall have to confine ourselves to indicating the general trend of the analysis.

In the first place *it is assumed that the resultant air forces are perpendicular to the chords of the sections. The*

(Continued on page 263)

Covering and Doping Airplanes

by F. NAGEL

Complete instructions for amateur airplane constructors on a critical part of the construction which has seldom been published in aeronautical magazines.

THE kind of covering job you do will make or break the looks of your ship and a good cover job starts with good fabric.

Use a good mercerized fabric, either of the medium weight for a very light ship, or the regular weight for a heavy ship. This fabric is sold under such names as Flitex, Dartmouth-Tex, etc., and under each brand there are sold several types of cloth, so you can easily pick out the type best suited for your ship.

The price of such fabric will average little more than that of inferior grades, but the quality and durability, well, that will average about five-fold. However, if you cannot obtain such a fabric, your best bet will be high grade unbleached muslin with about sixty to seventy or more threads to the inch.

Don't buy stuff that sells for about fifteen cents a yard, and expect to get a good cover job. It's impossible. Also purchase pinked tape of around one and one-half, to two and a quarter inches in width for taping the ribs, etc. Buy good dope and thinner, for even though good quality will cost more, the dope contains more solid matter and therefore fills and tightens better. A good thinner will cut the dope quicker, and produce better results, as well as make a job that will last longer.

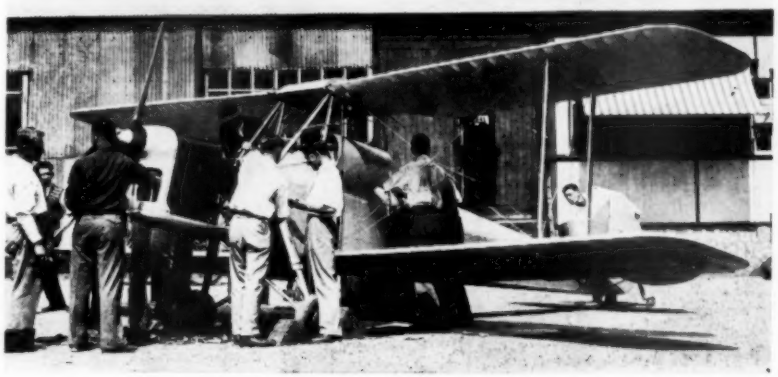
After you have got your materials, you will be ready to start on the covers. If there are no projecting fittings on any of the surfaces to be covered, or on the fuselage, you can make slip or bag covers, and thus speed up your work.

Say we start with the fuselage. Generally, this can be covered with three or four strips. A strip of fabric for each side, one for the bottom, and in some cases the cuttings from the tail end of the bottom can be used to cover the turtleback.

Pin the fabric together at the longerons so all the fabric is drawn taut, and cut off the surplus, leaving about two inches to spare all around. Then slip the cover off and sew along where pinned, the sewing line having been marked with pencil line beforehand.

Then, the cover is turned inside out, and pulled on the fuselage from the rear. Sew by hand where needed and tack where possible, so the cover is drawn taut, and is tight and smooth all around. Now your fuselage is covered.

For covering the wings, you start by wrapping the fabric around the wing to get the length needed to reach from the trailing edge around the front, and then back to the trailing edge on the underside. Leave about four inches to spare and cut off the strip. Then cut sufficient strips of the same length to cover all the wings.



A group of students after completing the covering and doping of a lightplane.

This is done so the long way, or the warp of the fabric, will be in the line of flight. The strips should be sewn together, double stitched as shown, so you will have a blanket of sufficient width to cover the wing. Then, the blanket is wrapped around the wing, inside out, if it is to be a slip cover, and pinned around the edges, while the fabric is drawn taut.

Pin about every six inches and mark the position of the stitches. Then sew once all around on the machine using good linen machine thread. Now you turn the bag inside out and pull it on the wing from the tip end. Pull the cover very taut, and tack or sew both sides to the butt rib.

It makes a better job if you tack the upper fabric to the bottom rib capstrip and the lower to the upper rib capstrip on the butt rib. Of course, tacking is used only when the butt rib is faced with plywood, or the capstrips are very heavy. Otherwise it should be sewed, using the baseball stitch. When the cover is ready to dope, it should be taut all over and there should be no wrinkles present.

After the wings and tail surfaces have been covered they should be lockstitched, using a seven-cord linen thread. First, you should run some reinforcing tape over the ribs on both wings and tail surfaces. The tape should be about the width of the capstrip, and of the herringbone weave. The tape is wrapped around the rib and pinned at the rear.

Then, you should get a needle about sixteen inches long, and thread it with the linen thread, allowing about three or four rib lengths. With the wing standing on its leading edge, begin at the trailing edge and lockstitch the wing every three or four inches along the rib, till the leading edge is reached. Lock every third stitch, and simply loop the rest.

All the wing and aileron ribs, as well as the tail surface ribs are to be taped with reinforcing tape and then lockstitched. For appearance sake, the cord should be allowed to lie to one side of the rib, and the knots should be tied on the side of the surface that is least visible, that is, on the under side of the stabilizers and flippers, as well as the lower wing, and top of the upper wing.

After the sewing and lockstitching have been finished, the surfaces should be ready to dope. As there are two methods of finishing—the spray and brush method—we will take up the brush method first. For the first coat, the dope is best thinned about twenty percent, with a good grade of dope thinner. Brush it in well and allow it to dry thoroughly.

When dry, scuff it very lightly with rough sandpaper to remove the hardened nap of the fabric. Do not sand over the lockstitch cords, or over places where there is a hard surface touching the fabric, for you are liable to cut through.

When the first coat has been sanded, you are ready to apply the second with the tape. Saturate the place that is to be taped with the thinned dope, and then lay the pinked tape in position, pull taut, and dope down thoroughly.

Incidentally, patches should be placed wherever fittings, etc., project, before the tape is laid. Same should be of the type fabric used, and should have the edges either pinked or frayed. All ribs, leading and trailing edges, and the outer edge of all surfaces should be taped, as well as the longerons and

fairing strips on the fuselage. The ribs are taped first and then the edges.

If you have trouble taping curved edges, try this method. First dope the beginning of the tape in position and let it dry. Then saturate beneath the tape, and the tape too, with thinned dope, and grasping the rear end of the tape with the hands, pull hard, so the tape is lying in position.

Pull hard enough so the major wrinkles vanish, and then, while the dope is still wet, rub out the remaining wrinkles with the fingers. Then dope over once again. In this manner you can tape curved edges such as wing tips, etc., without cutting the tape at the edge.

You can crease the tape down the center beforehand, if you wish to have it lie centered, with an even edge on both sides of the surface that is being taped.

Now that all the taping is completed, we can go ahead with our doping. Apply sandpaper, as mentioned beforehand, being careful that you do not cut through the tape into the lock-stitching. Then brush on the third coat of dope, brush in well, using a circular motion, and applying pressure on the brush, but do not attempt to brush the dope out as you would paint, rather flow it on.

Sand with medium sandpaper after this coat has dried. Mix fine aluminum powder with the dope, about six ounces to the gallon, and thin till it is about as heavy in body as clear dope. You will find that it will work better, if you first make a paste of the powder with some thinner, and then mix this paste with the clear dope.

Now brush on the fourth coat, using the aluminum dope you have mixed, and flow it on well. After it is dry, sand with medium sandpaper, and you will find that you have a good smooth surface. Now that you are using the brush method, brush on two coats of pigmented dope of the color you desire, thinning the last coat about twenty percent. This should cover the aluminum, and result in a well filled evenly colored surface.

In some cases you will find that another coat will be needed to cover the aluminum. It will give a good color job, but will not be quite as durable if the aluminum is omitted and the pigmented dope mixed for the fourth coat on the basis of one quart to the gallon of clear.

If your ship is very light and the structure rather frail, do not use over five coats. Start mixing a little pigmented dope with the third coat, use more for the fourth, and for the fifth use straight pigmented, thinned to brushing consistency.

For the brush method, in painting metal work, it works out well to use the desired color enamel, brushed on with a soft brush. Two or three coats should suffice, and care should be taken that the metal is thoroughly clean before it is painted. Clean of all oil, soap, fingermarks, etc.

If you possess spray equipment your ship can be given a smoother finish, as well as a better looking one. The same schedule is followed as for the brush method up to the fourth coat. The fourth coat should be aluminum, sanded with either medium sandpaper, or medium water sandpaper. Water sanding will produce a smoother job, and will not require as much paper, as the water keeps the paper from gumming up, but the cost of water sandpaper is greater.

The fifth coat of the desired color pigmented dope is now sprayed on. You will find it necessary to thin the dope considerably for spraying, and for this purpose you should use thinner, or reducer or anti-blush reducer on damp days.

The high humidity on damp days will cause the dope to "blush," or turn whitish, and this can be remedied by mixing reducer or anti-blush with the dope, about one-quarter pint to the quart. This slows up the drying of the dope, and thus helps eliminate blush.

If the blushing still persists, reducer or anti-blush can be sprayed over the

(*Concluded on page* 258)

GLOSSARY OF WORDS, TERMS AND PHRASES—DIC-A-49

Blade-section. The form of a propeller blade cross-section taken at right-angles to the length of the blade. It is the equivalent of an AIRFOIL or WING-SECTION.

Blade-sheath. A protective layer of metal or other hard material placed on the propeller blade tips to avoid attrition and erosion due to rain, water-spray or dust.

Blade-stresses. The stresses set up in the blade of a propeller by centrifugal force, by air-pressure against the face of the blade and by unbalance.

Blade-tip Velocity. The linear velocity of the outer tip or end of a propeller blade, generally in terms of feet-per-second. This should be kept below 950 feet-per-second, as the efficiency of the propeller drops off rapidly above this speed.

Blast. Air issuing from a nozzle at high velocity.

Blast Reactor. A means of propelling aircraft by means of air streams or jets acting toward the rear of the aircraft.

Bleached-oil. Colorless lubricating oil (stainless oil) produced by sun bleaching.

Bleeder. A drain for the removal of gas or liquid contents.

Bleeder-cock. A drain cock or valve.

Bleeder-stage. A stage in a turbine or a portion of the engine stroke from which a gas or liquid is taken for external service. This is at a pressure lower than the initial pressure but higher than exhaust pressure.

Blend. A mixture.

Blended Oil. A lubricating oil consisting of a mixture of a number of oils to attain a given purpose. Oils are frequently blended to obtain a given viscosity or other property.

Bleriot (Louis). A French pioneer in aviation. "The father of the monoplane."

Bleriot XI. The early and historical Bleriot monoplane, the "Cross-Channel" type, that first flew across the English Channel.

Blimp. A small non-rigid AIRSHIP.

GLOSSARY OF WORDS, TERMS AND PHRASES—DIC-A-50

Blind-flying. To fly under conditions of zero visibility, or to fly by the use of guiding instruments where the vision is masked.

Blind-flying Instruments. Guiding instruments for maintaining a course in conditions of poor visibility, as in fog or at night.

Blinkers. Two small stabilizing surfaces, pivoted and with limited movement, attached to the forward structure of the early Wright biplanes.

Blip. To open the engine throttle momentarily or to open and close the throttle quickly.

Blk. Abbreviation for black, or for block.

Bloater. A pre-war English training plane.

Bloc. (1) (French) Block or in "one piece." (2) A row of engine cylinders in one line. (French).

Bloc (en). In a block or in one piece. "En bloc cylinders" are a number of cylinders in a single casting or forging.

Block (Cylinder). (1) A casting or forging containing a number of cylinders in one piece or a row of cylinders in one line. (2) Small wedges placed under the wheels of an airplane to keep it from rolling forward while the engine is being tested.

Block-test. An engine test with the engine on a stationary stand. A shop test or a test for measuring the power and performance of the engine.

Bloom. A flourescence or glow reflected from the surface of oils. The bloom of a Pennsylvania or paraffin base oil is green, while that from an ASPHALTIC BASE OIL is a bright blue.

Bloomers. An early slang term for landing-gear streamlining or "PANTS."

Bloop. (1) A whooping or whistling sound caused in a radio receiver caused by the reaction of another radio receiver in the vicinity. (2) Carbureter popping or blow-backs.

Blow-back. Popping or explosions in the carbureter, generally due to a lean mixture or insufficient gasoline.

Elements of Airplane Design

by WILLIAM L. STIEGLITZ

A continuation of a series of articles dealing with the design and computation of lightplane elements.

IN the preceding article the first steps in finding the forces on the control stick of an airplane in any particular attitude were discussed.

It was found that one of the first things necessary is to find the angle of the stabilizer setting at cruising speed from the general equation for static longitudinal stability. Rewriting this equation:

$$C_{MA} = [C_{MO} + C_L(a/c - .25) + C_c b/c] - [(S_t/S_w)(1/c)(dC_L/da)_t \eta_t a_t] - [(S_s/S_w)(1/c)(dC_L/da)_t \eta_t a_t (1075T/D^2V^2)] + [Th/cS_w q] \quad (6)$$

All of the quantities involved in this equation except S_t, S_w, and $(dC_L/da)_t$ were discussed last month, although the expression for the angle of attack of the tail (a_t) given in equation 7 needs more elaboration.

Taking up these quantities in the order listed, the total area of the horizontal tail (S_t) necessary for stability can be determined by either of the two methods developed by Diehl[1]. The value of S_s can then be found by assuming that the diameter of the slipstream at the tail surfaces is equal to nine-tenths of the propeller diameter, and projecting such a circle onto the tail surfaces.

The value of the slope of the lift curve (dC_L/da) is approximately the same for all of the sections used for tail surfaces, varying only with the aspect ratio of the tail. For R = 3 it lies between 0.060 and 0.065, with an average value of 0.062. Combining this with a tail efficiency factor of 0.75 the product $(dC_L/da)_t \eta_t$ equals 0.0465, which is a good average value for use in design calculations, when wind-tunnel tests on a model of the actual plane are not available.

The only remaining values to be discussed lie in the expression for the angle of attack of the tail, a_t, which was given in equation 7 as:

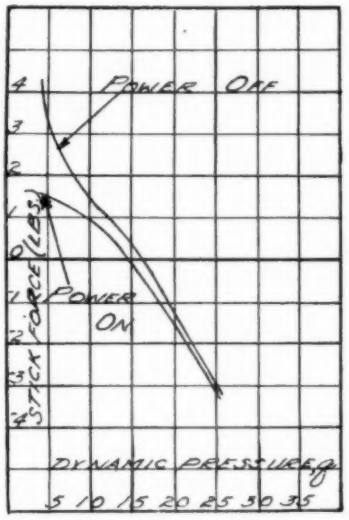
$$a_t = a_w - E + a_{to} + TB \quad (7)$$

Combining this with equation 5:

$$a_t = a_s + TB \quad (7a)$$

The simplest procedure is to develop an expression for TB in terms of a_s, solve equation 6 for this latter value, and then obtain the value of a_{to} by solving equations 7 and 7a.

The value of T, as was noted in last article, depends on the shape of the tail, and the ratio of the mean elevator chord to the mean chord of the entire tail. Fairly average values are obtained for a tail of the conventional shape, but it is to be borne in mind that the values listed below are exact only for that particular shape of tail.



Graph indicating the application of forces.

C_e/C_t	T
0.25	0.35
0.35	0.50
0.45	0.62

Practically every designer has his own ideas concerning the proper design of tail surfaces, and there are so many different designs in use, with slight differences between even those of the same general shape, that any really comprehensive data on the values of T for various shapes of surfaces can hardly be collected.

Consequently, exact values for any particular tail design can be found only by wind-tunnel tests of a model of the actual surfaces. However, the above values represent a fairly good average, and are sufficiently exact to be used in design calculations on surfaces the shapes of which are at all like that shown.

The elevator angle, B, in terms of a_s can be found from equation 4:

$$C_H = C_1 a_s + C_2 B \quad (4)$$

Since in this case $C_H = 0$, making: $B = -C_1 a_s / C_2$.

The significance of the two constants, C_1 and C_2 was discussed in last article, and once again it is sufficiently accurate to use average values, letting: $C_1 = 0.0025$ and $C_2 = 0.009$, so that:

$B = -.0025 a_s / .009 = -0.278 a_s$.

Substituting in equation 7a:

$a_t = a_s - 0.278 T a_s$.

This expression for a_t can be substituted in equation 6 and the latter solved for a_s directly.

Once a_s is known, the right-hand sides of equations 7 and 7a can be equated, and a solution made for a_{to}. The value of the angle of attack of the wing will be that corresponding to the lift coefficient at cruising speed, taken from the wing characteristic curves.

The lift coefficient can be found from the basic relationship:

$$L = C_L S V^2 e/2 \quad (10)$$

where L = total lift in pounds, which is equal to the gross weight of the airplane.

The value of the angle of downwash was discussed in last issue, the expressions with power on and power off being given in equations 8 and 9 respectively.

Knowing the angle of the stabilizer setting, the elevator angle, B, in any desired attitude of flight can be found by solving equation 6, and since a_s can be found readily, the hinge moment coefficient, the actual hinge moment, and the force on the stick can be found in order by solving equations 4, 2, and 1, respectively.

In order to outline these final steps more clearly, before proceeding with an illustrative example, consider the original problem of finding the stick force at landing. Since in landing the engine is idling, the plane can be treated as though the power were shut off completely, so that the propeller thrust is equal to zero, and the last two brackets in equation 6 will drop out of the equation. Consequently, the stability equation for the power-off condition reduces to:

$$C_{MA} = [C_{MO} + C_L(a/c - .25) + C_c b/c] - [(S_t/S_w)(1/c)(dC_L/da)_t \eta_t (a_s + TB)] \quad (11)$$

The elevators will be used to hold the airplane in balance in this condition, so the value of B must be such that $C_{MA} = 0$. Substituting this value, and solving equation 11 for TB:

$$TB = \left\{\frac{1}{(S_t/S_w)(1/c)(dC_L/da)_t \eta_t}\right\} \times \left\{[C_{MO} + C_L(a/c - .25) + C_c b/c] - [(S_t/S_w)(1/c)(dC_L/da)_t \eta_t a_s]\right\} \quad (12)$$

Then, by substituting the proper val-

1. *"Two Practical Methods for the Calculation of the Horizontal Tail Area Required for a Statically Stable Airplane," by W. S. Diehl, N.A.C.A. Tech. Report No. 293, 1928. Also to be found in "Engineering Aerodynamics," by W. S. Diehl, Ronald Press, 1929, pp. 94-102. And in "Aviation Handbook," by E. P. Warner and S. P. Johnston, McGraw-Hill Co., 1931, pp. 196-202.*

ue of T, after solving equation 12, the value of B can be found and equation 4 will then give a solution for the hinge moment coefficient. The values of C_t and C_r given above can be used, so:

$C_R = .0025a_s + .009B.$

Equation 2 will then be solved for the actual hinge moment H:

$H = C_H C_e S_e q,$

and equation 1 for the force on the stick:

$F = kH/L.$

As to signs, elevator angles are measured positive downwards, so that B is negative for up elevator. However, when it comes to a consideration of stick forces, the convention is that a pull on the stick is positive, and a push negative, so that a negative elevator angle produces a positive stick force.

While this seems rather contradictory, and unless one is careful, may lead to a confusion in signs, the two conventions both have sound bases, elevator angles being negative upwards since in that direction they reduce the angle of attack of the tail, and stick forces being measured as they are because it is natural to consider a pull as positive.

At high elevator angles there is decrease in effectiveness, especially when the airplane approaches the stall, and the air flow over the tail is disturbed. Consequently it is best to increase the maximum value of B by 25% in order to compensate for the loss in efficiency.

Turning, now, to the plane which was described and of which a three-view drawing was published in last month's article, and computing the stick forces for this plane, in order to illustrate the method outlined above:

W = 1,000 pounds.

Wing section is tapered N.A.C.A. 2218-09. Computing wing area to give stalling speed of 40 m.p.h.:

$W = C_L Sq$

$q = V^2e/2 = (40 \times 88/60)^2 \times .001189 = 4.09.$

C_L (maximum) $= 1.6$

$\therefore S = W/C_L q = 1000/1.6 \times 4.09 = 153$ square feet.

The cruising speed can be assumed to be 80% of the maximum speed, which latter can be found by any of the numerous methods of performance estimation which have been developed.

$V_{max} = 117$ m.p.h.

$V_{cruise} = 0.8 \times 117 = 93.6$ m.p.h. $= 93.6 \times 88/60 = 137.5$ f.p.s.

At cruising speed:

$C_L = W/Sq = 1{,}000/[153 \times .001189 \times (137.5)^2] = 0.291$

$a_w = 2°$ (from wing curves).

Finding S_t/S_w by Diehl's second method:

$S_t/S_w = 0.125$

$\therefore S_t = 0.125 \times 153 = 19.1$ sq. ft.

For $C_e/C_t = 0.35$ and $T = 0.50$,

Span of tail $= \sqrt{RS} = \sqrt{3 \times 19.1} = 7.57$ feet.

$C_t = 7.57/3 = 2.52$ feet.

$\therefore C_e = 0.35 \times 2.52 = 0.882$ feet and

$S_e = 0.35 \times 19.1 = 6.69$ square feet.

In order to find the diameter and the efficiency of the propeller, it will be necessary to go through simple design calculations for a prop. The best way to do this is to use the method and charts developed by Weick.

R.p.m. = 2,150

C_s = Speed-power coefficient

$$= \frac{0.638 \text{ (m.p.h.)}}{(\text{hp})^{1/5} \times (\text{r.p.m.})^{2/5}}$$

$$= \frac{.638 \times 117}{65^{1/5} \times 2150^{2/5}}$$

$$= \frac{.638 \times 117}{2.30 \times 21.5} = 1.51$$

Picking an all-around service propeller, which is half way between that developing its peak efficiency at C_s and that developing the maximum efficiency:

$7 = 0.78$ for metal propeller

$V/ND = 0.78$

$D = (117 \times 88)/(0.78 \times 2{,}150) = 6.14$ ft.

$= 6$ feet, 2 inches.

$\therefore S_e = 14.4$ sq. ft., and $S_e/S_w = .094$

(*Concluded on page* 256)

GLOSSARY OF WORDS, TERMS AND PHRASES—DIC-A-51

Blower. A fan or rotary air-pump used for delivering large volumes of air at comparatively low pressures. Employed for delivering a blast of air over the cylinders of an air-cooled engine or for delivering an air-gasoline mixture to the cylinders under a pressure. (See SUPERCHARGER).

Blower (Centrifugal). An air-pump consisting of revolving blades that creates air-pressure or air movement by the rapid rotation and centrifugal force developed by a mass of air. The blades do not contact the casing. Pressures up to 16 ounces.

Blower-Clutch. (1) A clutch for engaging or disengaging a BLOWER from the source of power. (2) An automatic device which is inserted in the blower drive system to prevent heavy stresses when the blower or engine is started suddenly. Such clutches slip and thus avoid sudden acceleration.

Blower (Positive). A rotary air-compressor for moderate pressures which consists of revolving pistons, vanes or lobes which make air-tight contact with the casing and which revolve at a lower speed than the CENTRIFUGAL BLOWER. Pressures up to 25 pounds per square inch.

Blower (Root-type). A positive blower having two revolving impellers or two-tooth gear lobes which make contact with a casing.

Blue. The sky or upper atmosphere.

Bluff Entry. A moving body having the blunt or wide end forward so that this end enters the air.

Boat. A buoyant water supported vehicle designed with a view of easy propulsion by reason of its form.

Bob. (1) A heavy concentrated weight on a pendulum control.

Bobine (French). Coil of wire.

Boche. Wartime expression meaning German.

Body. (1) The FUSELAGE or hull of an aircraft. Also the NACELLE or cargo-carrying portion of an aircraft. (2) Viscosity of a liquid (such as oil). The degree of fluidity, or the ease with which a liquid flows.

Body-capacity. (Also hand-capacity). The detuning effect of a radio receiver with a strong external field. A set of this sort is detuned when approached by the hand.

Body-resistance. Resistance of the fuselage when moving in air.

GLOSSARY OF WORDS, TERMS AND PHRASES—DIC-A-52

Body (Streamline). An object of such shape that it causes no turbulence or discontinuous masses of air. A body that moves through the air with a minimum of resistance. In general, a body with a blunt entering end and a thin tapering trailing end.

Bog-down. To sink deep in mud, clay or snow so that progress is difficult.

Boil. The rapid formation of vapor within a liquid by the application of heat so that the liquid is greatly agitated and heaves rapidly as the vapor passes up through the liquid. See EBULITION.

Boiler. A closed vessel in which vapor pressure is established by boiling a liquid. The liberated vapor produces pressure.

Boiler (Flash). A boiler in which steam is produced by spraying the water into the hot boiler in proportion to the steam required. No reserve water is held within the boiler. Steam is produced rapidly and the boiler is safer than a boiler holding water. This type of boiler has been used for steam propelled automobiles and to a limited extent in aircraft.

Boiler-feed. The water or liquid supplied to the boiler.

Boiler Feed-pump. A pump employed for forcing water or other liquid into a boiler against boiler pressure.

Boiler-furnace. The space in which the fuel is burned for providing heat for a boiler.

Boiler (Fire-tube). A type of boiler in which the hot gases from the furnace pass through the boiler by means of tube or FLUES, the water surrounding the tubes.

Boiler (Water-tube). A boiler in which the water is contained within tubes, the heat being applied to the outside of the tubes.

Boiling-point. The temperature as which a liquid boils—fixed temperature for a given liquid and pressure. Water boils at 212°F. (100°C.) at normal sea-level pressure. The temperature increases with an increased pressure and decreases with a decreasing pressure. Liquid carbon dioxide boils at -110°F.

Boiling-temperature. See BOILING-POINT.

Bois (French). Wood.

Bois doux (French). Soft wood.

Possibilities of Rotorcraft

by ALVIN EDWARD MOORE
(Examiner in U.S. Patent Office)

A second article by this author in which further disclosures are made concerning the adaptability and practicability of the rotor type of aircraft.

THE future successful rotorcraft should have the following characteristics:

(1) One or more slim rotors with as large a total length exposed to the air current as is practicable;

(2) The rotors having discs closing their ends that are larger in diameter than the cylinders;

(3) The rotors rotating with a normal circumferential speed three to four and one-half times as great as the velocity of the wind (so that the direction of lift normally will be at right angles to the direction of the air current);

(4) The rotors driven by a motor which is not likely to fail;

(5) The speed of the rotors, or the speed of the air current, or both, being variable, so as not only to vary the lifting force on the machine but to vary the direction of that lifting force.

Instead of (5), the following characteristic might be made use of:

(6) Rotors movable so as to vary the amount of rotating surface exposed to the air current.

Now let us see what has been done toward the realization of this ideal rotorcraft.

Professor Magnus of Berlin discovered the basic principle in 1853.

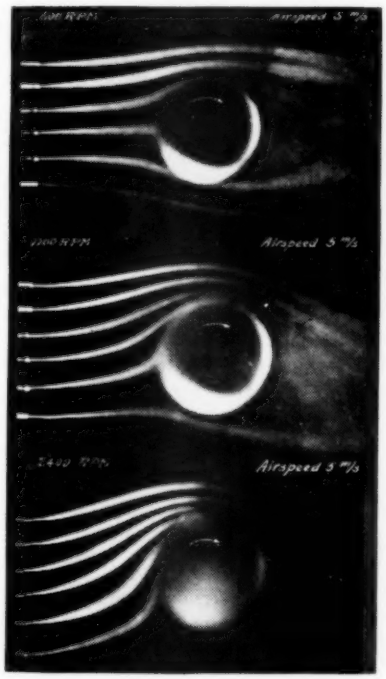
In 1908 Butler Ames, a U.S. Representative of Lowell, Massachusetts, filed an application—on which he was granted a patent—for his two rotors which were the result of his experiments with captive rotating cylinders on the U.S.S. Bagley at Annapolis, Maryland.

In 1915, Walter and Clarence Scotter of Kingston-upon-Hull, England, filed application for their British patent for Magnus rotors—one on each side of the fuselage.

In 1918 Arnaldo Romualdi of Jersey City, New Jersey, filed an application on which he was granted a patent for putting rotors at the trailing and the leading edges of airplane wings, the rotors turned by the engine that drove the forward propeller.

In 1922 Anton Flettner of Berlin, famous inventor of the rotorship *Baden-Baden* which crossed the Atlantic propelled only by the force of the wind on its high vertical rollers, began his experimentations with rotors. He discovered and applied the second and third of our above-listed features that should be incorporated in a good rotor aircraft. He built and operated the famous ship, and in his patent application (examined by the writer) incorporated the Magnus effect in airplanes.

Thus, by 1924 the above-named inventors achieved the first three characteristics that we need. They are the early pioneers of the rotorcraft. Magnus, Ames, and Flettner apparently are the only ones who made practical experiments to test their ideas.



A rotor revolving in a wind-tunnel. Above. Rotor idle. Center. Rotor at low speed but lifting. Bottom. Rotor running at high speed and delivering maximum lift.

Since 1924 many inventors have been working on the remaining problems, most of them apparently not conversant with the work of the others, due to the absence of literature other than isolated patents on this work.

Some of these patents are the following:

F. A. Howard of Elizabeth, New Jersey, application filed 1925, with rotating steel or fabric belts instead of rotors for the lifting effect;

O. L. Dally of Cleveland, Ohio, filed 1925, rotors driven by a windwheel in an air funnel;

W. J. H. Strong of Chicago, filed 1925, for rotors of variable speed of rotation, in front of the leading edges of the wings;

S. Trey of Sanford, Conn., filed 1926, rotors as leading edges of helicopter blades;

Frederick Wander, Jr., of New York, several patents for rotors in place of airplane wings and helicopter blades;

E. F. Zaparka of New York (assignor to the Zap Development Corp., Wilmington, Delaware), two patents filed in 1929—one for three rotors, one above the other, that may be pivoted as a unit in the slipstream, thus varying the amount of lift—the other for roller bearings for rotors;

C. E. Smith of Oroville, California, filed 1928, rotors in leading edges, turned by a shaft, with a small gasoline motor on the shaft between them;

N. J. Medvedeff of Scarsdale, N. Y., filed 1930, two patents—one for telescoping rotors below wings—the other for rotors pivoted to the fuselage so that they may be folded during flight to decrease their resistance;

Ora F. Bowers of Los Angeles, filed 1929, a revolving canvas in the form of an endless band in the leading edges of wings;

L. Sonsteness, Pontiac, Michigan, filed 1930, three parallel rotors, corrugated, extending through the fuselage, taking the place of wings;

A. F. La Fon of New York, filed 1931, helicopter with rotor propellers.

The above, mostly United States patents, are illustrative of the work going on in various corners of the world on this problem.

In 1930 a rotor aircraft was built in secrecy on a barge in Mamaroneck, New York. It had an all-metal fuselage, similar to that of a seaplane, with long, spool-like cylinders (two feet in diameter with end disks four feet in diameter) in place of conventional wings. One motor in the nose of the craft drove a three-bladed forward propeller and an air-cooled, Wright Gypsy motor of 90 h.p. farther aft in the fuselage rotated the cylinders. The craft was supported in the water on a pair of Edo floats. The span of the rotors was less than the span of conventional wings. There were no ailerons.

An air of mystery surrounded the building and operation of this rotorcraft, but it is reputed to have been flown successfully, lifting nearly ten times the useful load of a winged plane.

The National Advisory Council for Aeronautics of Washington, D. C., has investigated the possibility of using rotors in aircraft and has definitely concluded that sufficient lifting force is inherent in their operation to lift a craft, but in view of the faults of the designs made to date does not seem to be optimistic about their use in the future.

Thus we see what has been done. Now what remains to be done, and how may it be accomplished?

(Concluded on page 256)

Building the Corben Super-Ace

by O. G. CORBEN

The fourth article in a series of constructional articles telling how to build a sweet Ford powered lightplane. Detail working drawings accompany this article.

BY the time you read this article, I hope that the good old springtime is well on its way and has started your flying blood to boiling, for from the looks of things this is going to be a year in which aviation will step out and strut its stuff. So—if you are going to be among those who explore the old ozone, I'd suggest that you mix up a batch of glue, get out the blue prints, get going on your sportplane.

I feel pretty good, for I am sure that there is at least one reader who ventures to read these articles in detail. When I say "detail," I mean just that very thing, for in the first two drawings he found a mistake in the three-view drawing so I will pass it on to you. On the drawing, the dimension showing the distance between the aileron and the wing is only ½", whereas on drawing A-2 it is shown as 1½". The latter is correct. Thanks a lot, "Miller." I guess that was the drawing I made up about New Year's (following New Year's Eve).

Another thing I wish to call to your attention is that these drawings are reproduced from our large factory drawings and the scale shown is not correct for these as they are reduced, however, all the dimensions are given so I do not think you will have any trouble along this line.

Oh, yes. Some letters have come to me in regard to the wing curve, saying the dimensions for the rib layout were not given on the drawings. This was not shown for by the time it was rescued for publication, it would have been too small and no doubt would have resulted in several mistakes, therefore it will be necessary for you to lay the airfoil out from a Clark "Y" chart.

Three-quarters rear view of the Corben Super-Ace Ford motored lightplane described in this article.

It seems that there are a lot of sportplane fans who confide in pilots (heroes to them) in hope of receiving some encouragement towards building a ship such as the Super-Ace and it nearly always results on discouragement from said pilot. The advice he hands down to the poor sportplane enthusiast is, as a rule, quite a bit "out of rig," (if you get what I mean), so let's pause for a second before we take up the hammer and saw and get this thing straight.

The pilot generally says that sportplanes are a waste of money, that they are tricky to fly and so on, far into the night. Then, when you mention the idea of using a Ford motor for "soup," well, it is just more than he can stand and he explodes into a dozen pieces. All of this coming from the hero naturally puts the blocks under our sportplane fan's ambition and he turns his efforts to collecting stamps or butterflies.

But to get right down to the truth of the matter, we find that the aforesaid pilot has only seen one home-built job and that was 'way back when there was very little to work from along the sportplane line and if you wanted to build your own ship you had to guess what it was all about. Of course, most of these jobs did not make such a good impression and our pilot was sold on big planes with lots of power, has not paid any attention to some of the later sportplane developments and does not take into consideration that everyone does not have the means and wherefore to go out and invest several hundred or thousand dollars in big ships, so for the sole benefit of you broken-hearted sportplane fans, let me pass on a word of encouragement.

I have flown lots of different planes, little ones, big ones, good ones and bad ones, factory-built ships, some built in hay lofts and basements and I should know what I am talking about when I say that a sportplane, which is properly designed, is really easier to fly than a large plane. It is far better for the amateur than some job which comes in like a streamlined brick and as for building the ship yourself, a little time combined with pride in your work will result in just as good a ship as if it were built in some big factory. If anyone tells you different, let it go in one ear and out the other.

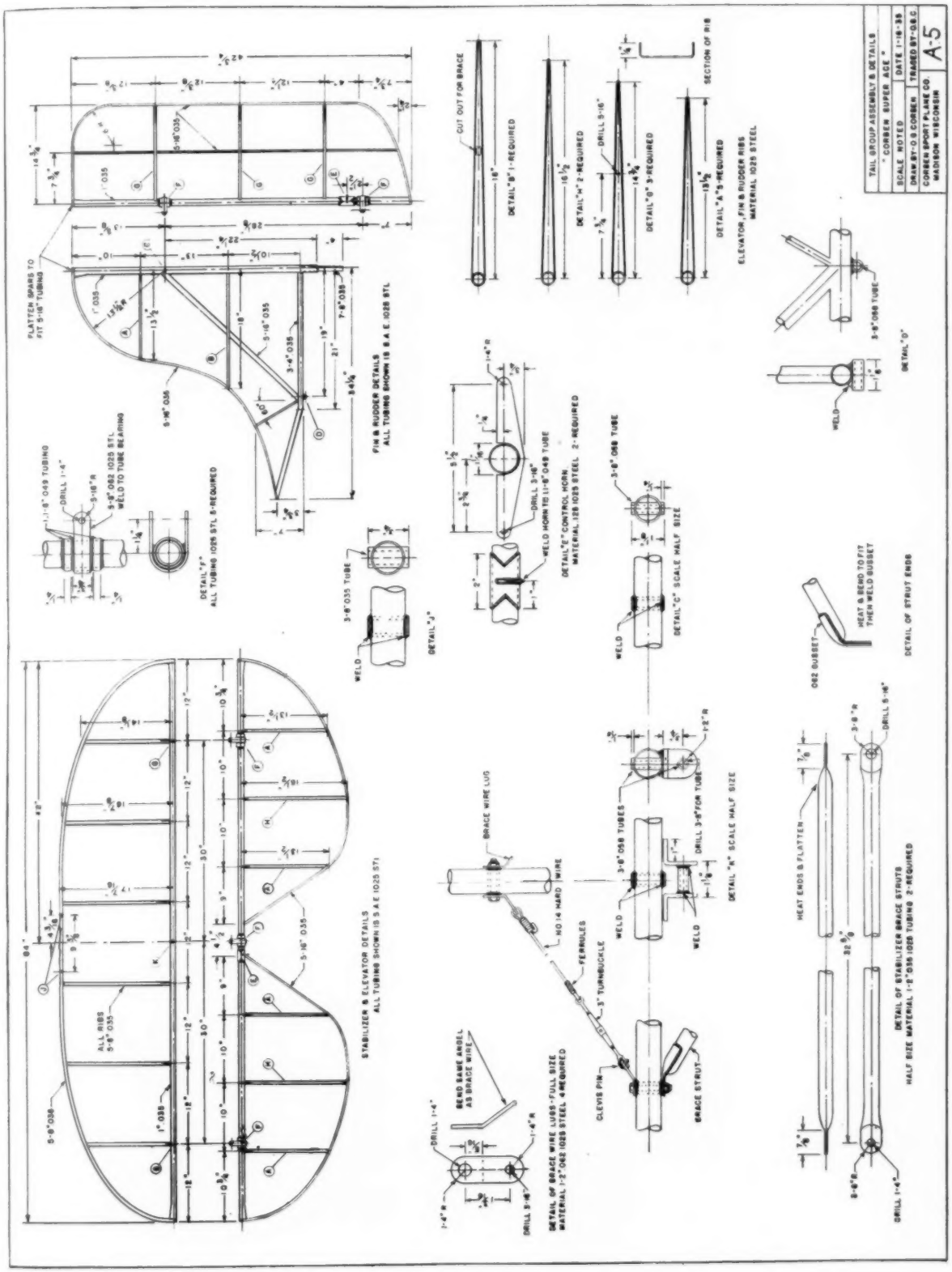
Just a word about the Ford power plant. Here is as sweet a little engine, when properly converted, as you would care to see. Its only drawback is its weight and so far this has not been a handicap in our ship for we obtain very good performance. One of the outstanding advantages of the Ford motor is the lack of attention. On an aircraft motor you wear out a set of tools overhauling the thing but with the old Ford all you do is put in gas and oil.

The gas tanks on the Super-Ace are

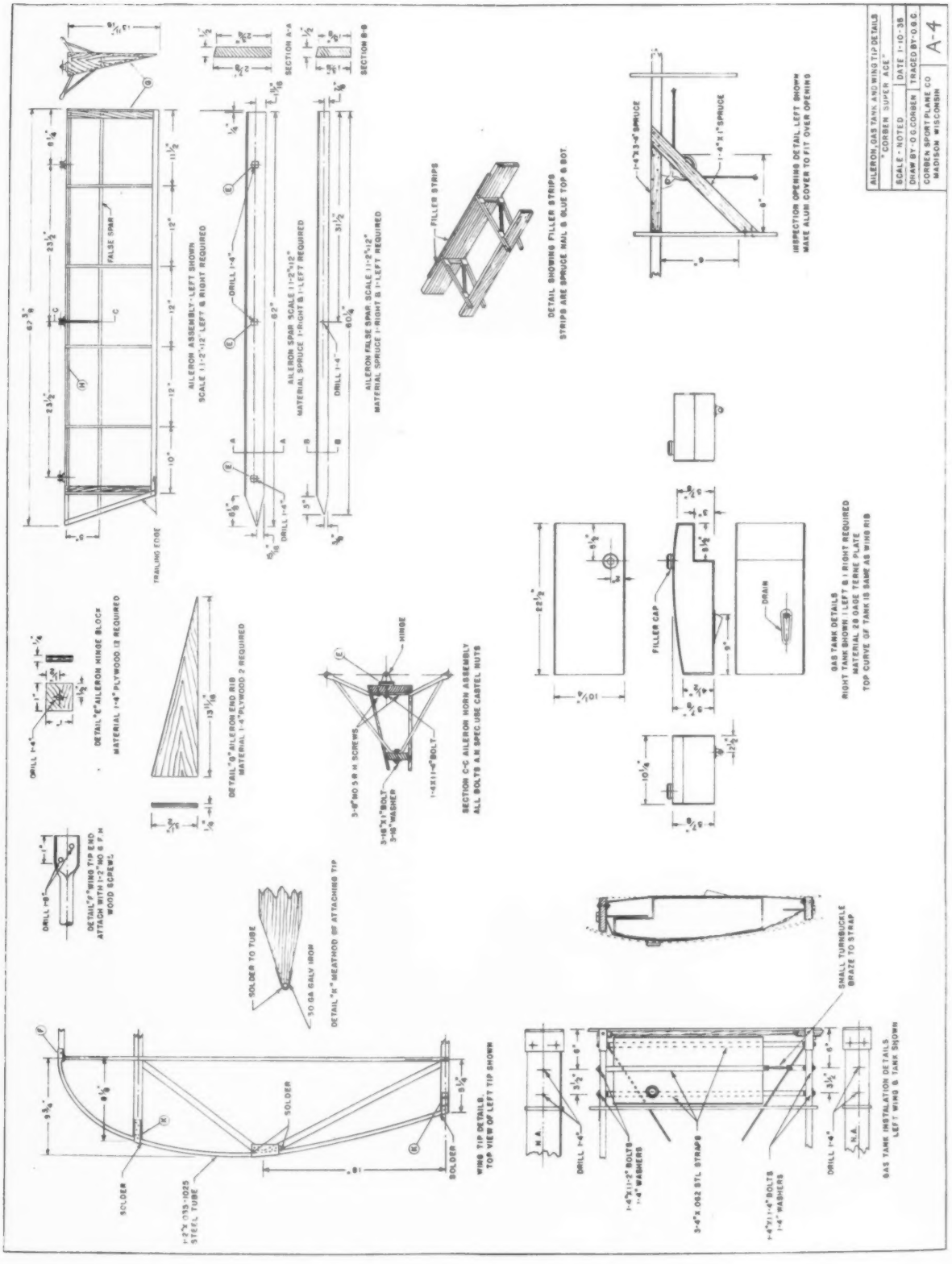
(Concluded on page 259)

The partly completed Corben Super-Ace Lightplane before the wings and fuselage were covered.

Tail Group of the Super-Ace



Ailerons for the Super-Ace


AILERON, GAS TANK AND WING TIP DETAILS
"CORBEN SUPER ACE"
SCALE - NOTED
DATE 1-10-38
DRAWN BY - O.G. CORBEN
TRACED BY - O.B.C.
CORBEN SPORT PLANE CO
MADISON WISCONSIN
A-4
AILERON ASSEMBLY - LEFT SHOWN
SCALE 1"=2"-1/2" LEFT & RIGHT REQUIRED
FALSE SPAR
TRAILING EDGE
SECTION A-A
SECTION B-B
AILERON SPAR SCALE 1"=3"-1/2"
MATERIAL SPRUCE 1-RIGHT & 1-LEFT REQUIRED
AILERON FALSE SPAR SCALE 1"=3"-1/2"
MATERIAL SPRUCE 1-RIGHT & 1-LEFT REQUIRED
FILLER STRIPS
DETAIL SHOWING FILLER STRIPS
STRIPS ARE SPRUCE NAIL & GLUE TOP & BOT
INSPECTION OPENING DETAIL LEFT SHOWN
MAKE ALUM COVER TO FIT OVER OPENING
DETAIL "E" AILERON HINGE BLOCK
MATERIAL 1-4" PLYWOOD 13 REQUIRED
DETAIL "G" AILERON END RIB
MATERIAL 1-4" PLYWOOD 2 REQUIRED
HINGE
SECTION C-C AILERON HORN ASSEMBLY
ALL BOLTS A.N. SPEC. USE CASTEL NUTS
FILLER CAP
DRAIN
GAS TANK DETAILS
RIGHT TANK SHOWN - LEFT IS 1 RIGHT REQUIRED
MATERIAL 28 GAGE TERNE PLATE
TOP CURVE OF TANK IS SAME AS WING RIB
DETAIL "F" WING TIP END
ATTACH WITH 1-1/2" NO 8 F.H. WOOD SCREWS
DETAIL "F" METHOD OF ATTACHING TIP
SOLDER TO TUBE
SOLDER
WING TIP DETAILS
TOP VIEW OF LEFT TIP SHOWN
SMALL TURNBUCKLE
BRAZE TO STRAP
GAS TANK INSTALLATION DETAILS
LEFT WING & TANK SHOWN

A Corben Super-Ace Model

by

PAUL W. LINDBERG

Model editor and model designer for
POPULAR AVIATION

Compare this completed model with the picture on the cover of this issue. It is true to life and a good flyer.

WE are sure most of you fans are familiar with this popular sport model, which is powered with a Model "A" Ford motor.

The model is an extremely good flyer, having unusual stability, plus speed and duration. This model, like all other models developed by our laboratory, carries all possible details in accordance with the real ship. All movable controls with aluminum hinges, a real shock-absorbing landing-gear, radiator with screening, exhaust pipes, and scale propeller go into the making of this trim model.

COLOR SCHEME

Wings and tail surfaces — yellow, fuselage—black and yellow, struts—black, spinner—red.

CONSTRUCTION OF FUSELAGE

First, place wax paper on top of plan, to prevent parts from sticking to plan. The fuselage sides are built from 1/16″ square balsa. The longerons, verticals, diagonal braces, etc., are held in place until securely cemented by inserting straight pins on either side of strips wherever needed.

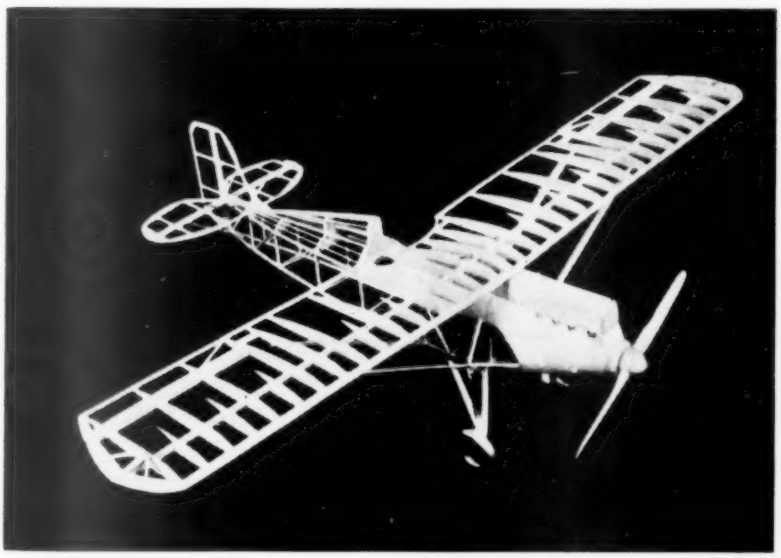
When the two sides are completed, the cross-members are cemented into their proper locations. Check carefully front to rear for alignment. Cut the formers from 1/32″ sheet balsa and cement in their respective positions as shown on plan.

The positions of all stringers are shown on the formers, there are very few stringers on this model, as the sides of the fuselage are flat. Three short stringers are placed between Former 6 and the bottom cross-member of fuselage.

Take great care in making all balsa nose blocks. The front part of fuselage back to cockpit is covered with several pieces of stiff paper, see plan. The louvers in side cowls may be made to stand out by cutting a slit in the back edge and gradually work an opening to confirm with that shown on the plan.

LANDING-GEAR

This is made in very much the same manner as the landing-gear on the large ship. The details are very clearly shown on the plan, and no trouble should be encountered here. It is very necessary that you splice in a piece of 1/16″ dowel in front wing strut to receive load from shock strut.



This gives you a good idea of what the framework of the Super-Ace looks like before covering.

CONSTRUCTION OF THE WING

Cut all ribs from 1/32″ balsa. Pin center spar in position on the plan. Now, cement ribs in their proper locations. The leading and trailing edges are cut and sanded to shape and cemented to the ribs. The wing panels carry movable ailerons which are a great help in controlling the flights. Make wing tips from 1/16″ thick balsa. We highly approve of this type of wing tip, because it is much easier to construct and neater in appearance.

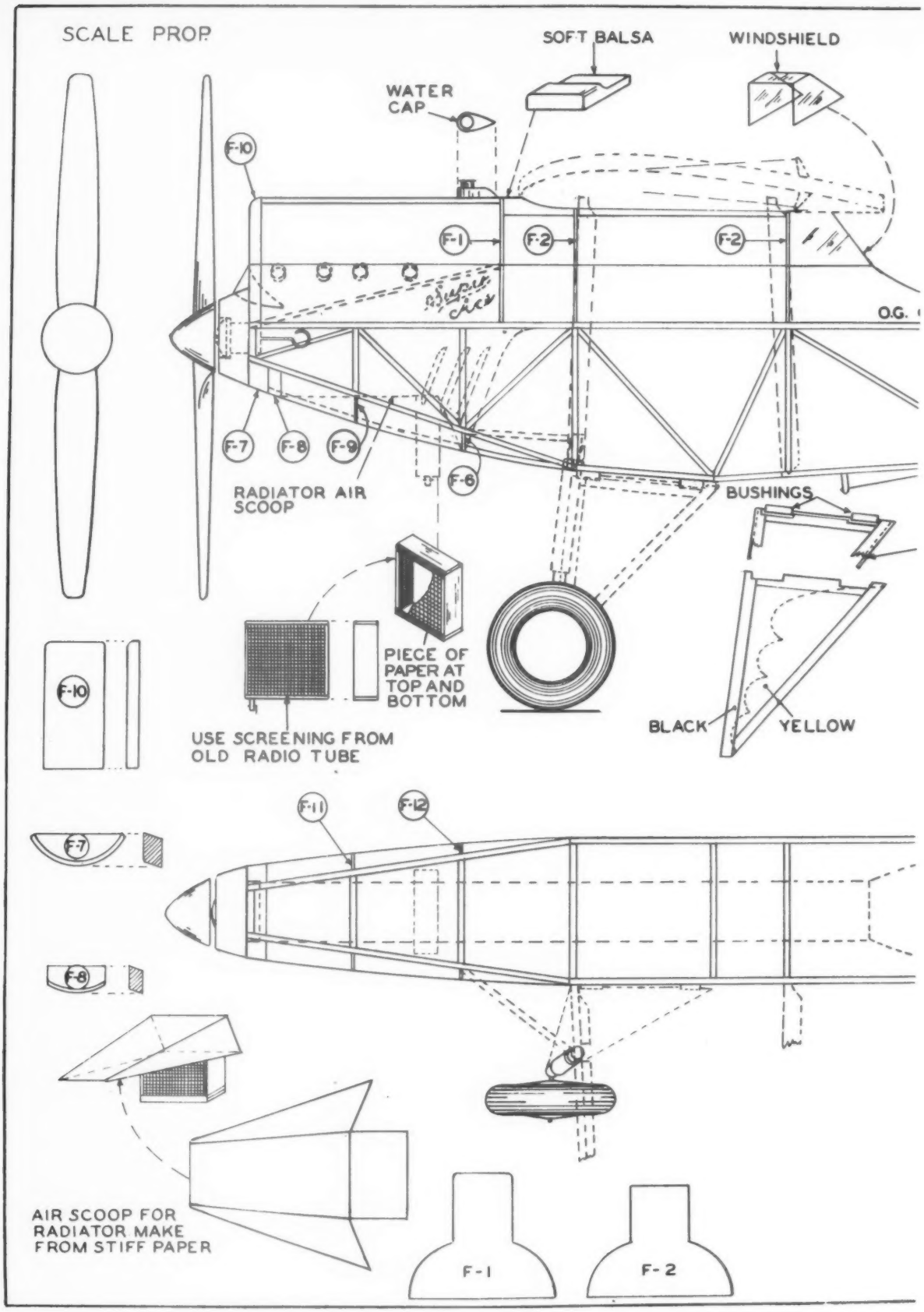
ELEVATOR AND RUDDER

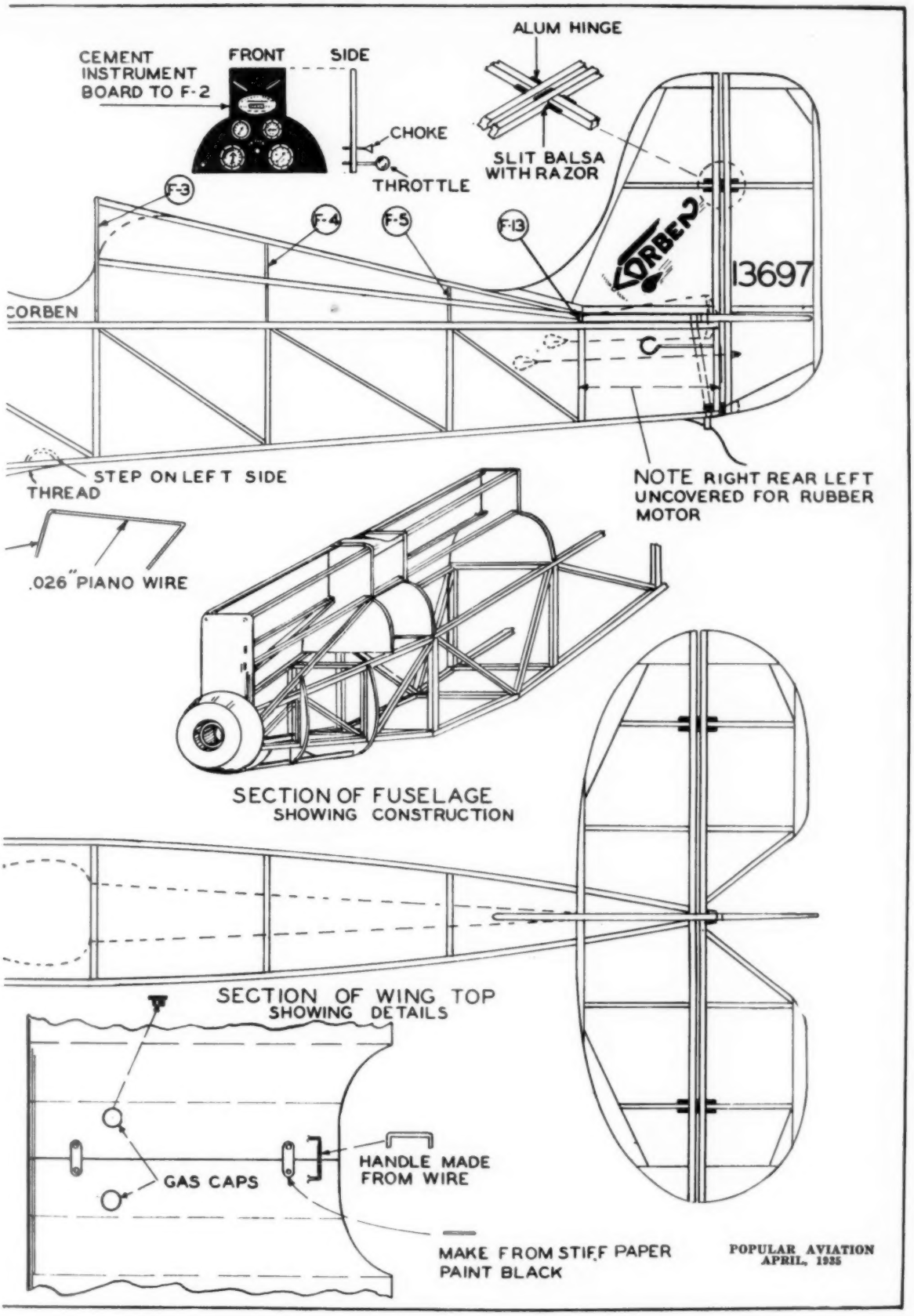
The elevator and rudder are built from 1/16″ square, and 1/16″ flat for the curved edges. Build all parts upon the plan. Note: All these surfaces are movable with aluminum hinges.

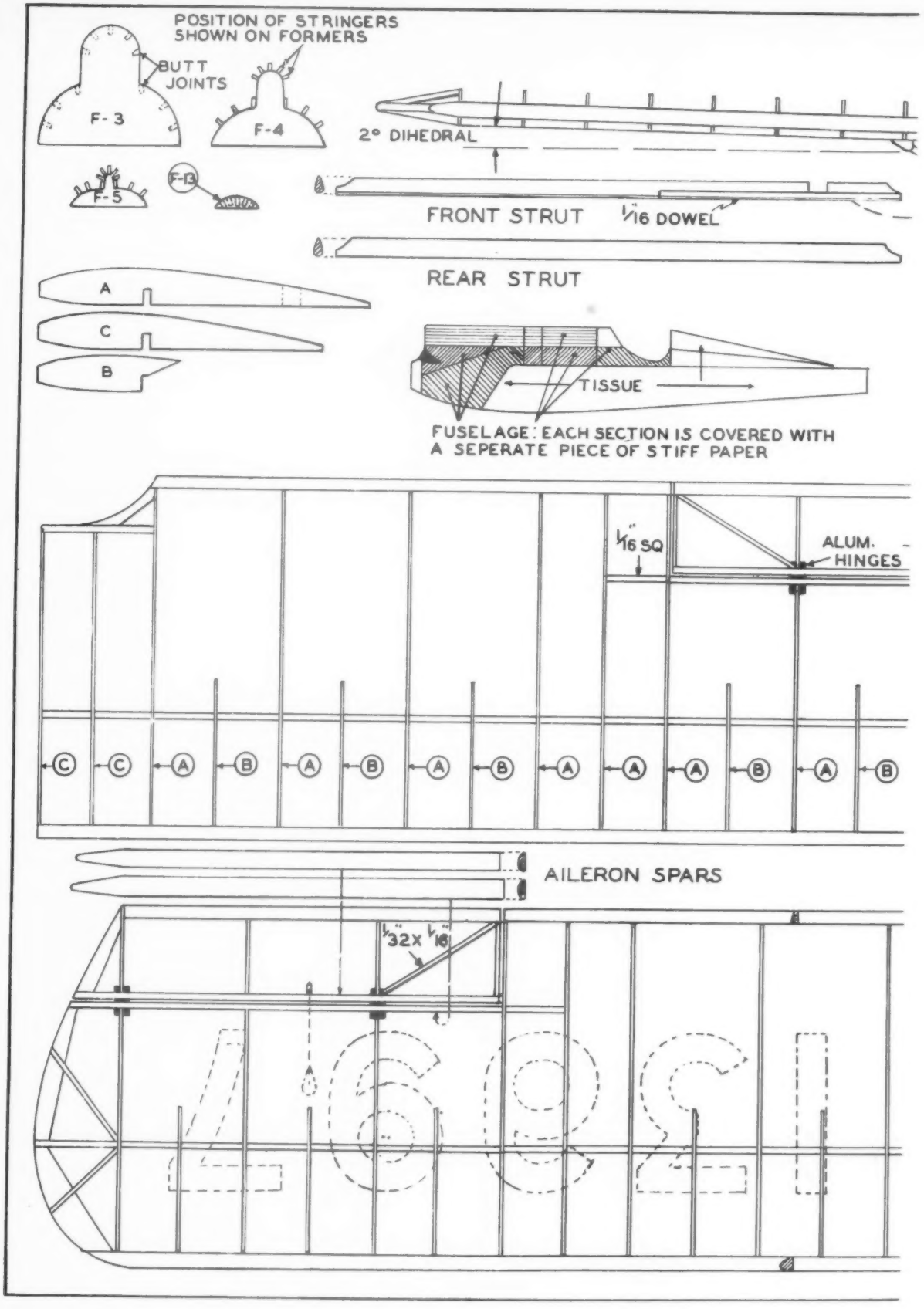
COVERING THE MODEL

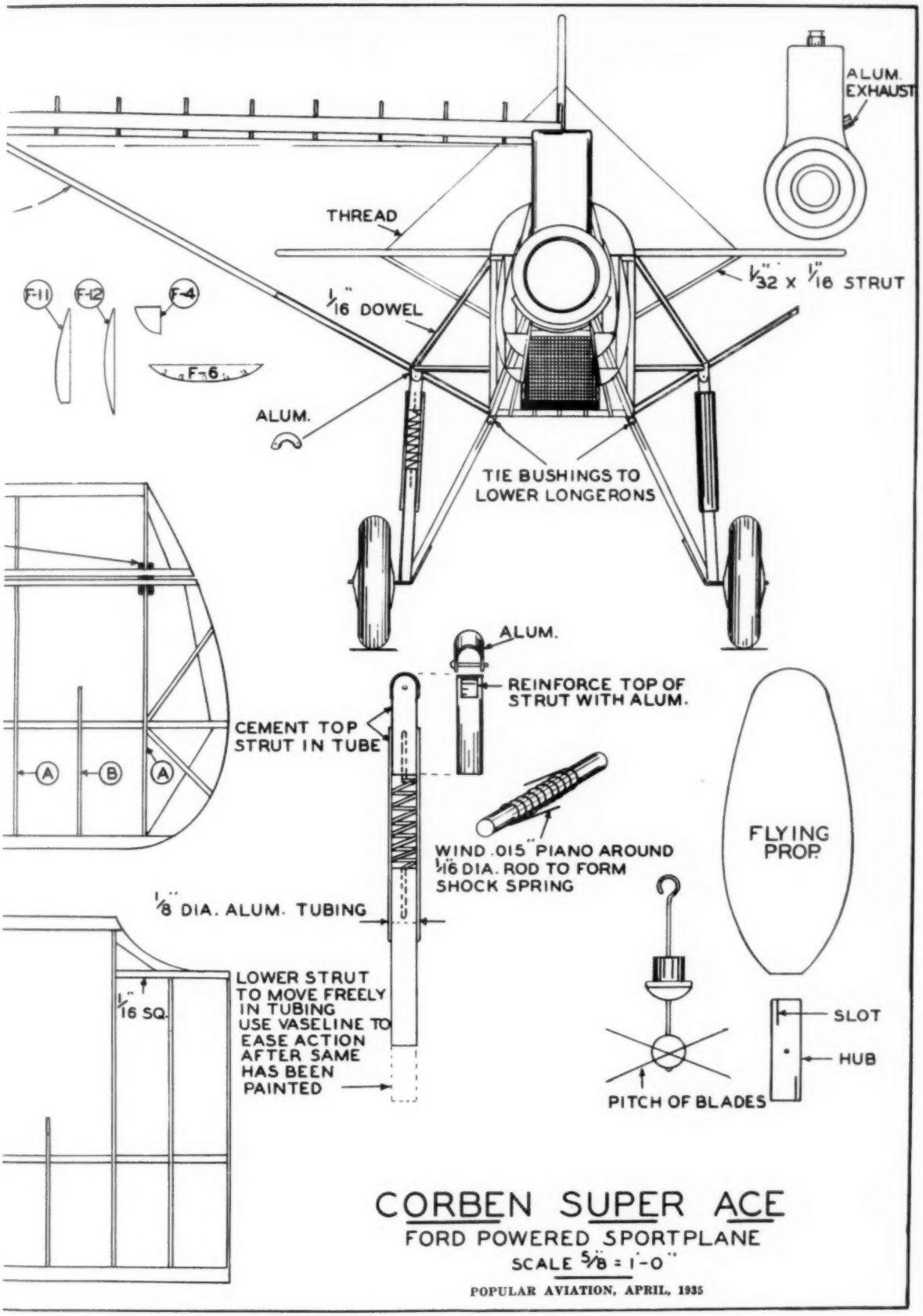
Apply tissue to the various framework members, using a light grade of

(Concluded on page 262)


SCALE PROP
SOFT BALSA
WINDSHIELD
WATER CAP
F-10
F-1
F-2
F-2
O.G.
F-7
F-8
F-9
F-6
RADIATOR AIR SCOOP
BUSHINGS
PIECE OF PAPER AT TOP AND BOTTOM
F-10
USE SCREENING FROM OLD RADIO TUBE
BLACK
YELLOW
F-11
F-12
F-7
F-8
AIR SCOOP FOR RADIATOR MAKE FROM STIFF PAPER
F-1
F-2


ALUM HINGE
CEMENT INSTRUMENT BOARD TO F-2
FRONT
SIDE
CHOKE
THROTTLE
SLIT BALSA WITH RAZOR
F-3
F-4
F-5
F-13
CORBEN
13697
CORBEN
STEP ON LEFT SIDE
THREAD
.026" PIANO WIRE
NOTE RIGHT REAR LEFT UNCOVERED FOR RUBBER MOTOR
SECTION OF FUSELAGE
SHOWING CONSTRUCTION
SECTION OF WING TOP
SHOWING DETAILS
GAS CAPS
HANDLE MADE FROM WIRE
MAKE FROM STIFF PAPER PAINT BLACK
POPULAR AVIATION
APRIL, 1935


POSITION OF STRINGERS SHOWN ON FORMERS
BUTT JOINTS
F-3
F-4
F-5
F-13
2° DIHEDRAL
FRONT STRUT
1/16 DOWEL
REAR STRUT
A
C
B
TISSUE
FUSELAGE: EACH SECTION IS COVERED WITH A SEPERATE PIECE OF STIFF PAPER
1/16 SQ
ALUM. HINGES
C C A B A B A B A A A B A B
AILERON SPARS
1/32 X 1/16



CORBEN SUPER ACE

FORD POWERED SPORTPLANE

SCALE 5/8" = 1'-0"

POPULAR AVIATION, APRIL, 1935

What the Industry is Doing

Latest bulletins from the airplane, engine, equipment manufacturers and dealers boiled down into a nutshell. Contributions to this department are invited.

ORDERS for four new Sikorsky Brazilian "Clipper Ships" have been placed with the Sikorsky Aviation Corporation by the Pan-American Aviation System. The new orders involve an investment of slightly over $1,000,000 and are additional to the aircraft called for under the Pan-American's two-year procurement program. This will give a total fleet of ten "Super-Clipper Ships," all of which are giant four-engined flying boats and all of them are capable of operating either across the Atlantic or Pacific oceans.

A BOEING 247-D has been delivered to Marshal Chang Hsueh Liang of China for his personal service. This plane will greatly assist further sales of American equipment in the Orient and will introduce a new era in Chinese aviation. It is Wasp powered and is provided with controllable-pitch propellers.

PRODUCTION of the Kruesi Radio Compass for the use of airlines, commercial operators and private pilots has been announced by the Fairchild Aerial Camera Corporation, manufacturers of aerial cameras and instruments. This radio compass, developed by the U.S. Army Air Corps and used by the corps as a standard unit, thus becomes available for the first time for civilian service. It utilizes broadcast programs as well as the signals broadcast by the Federal airways radio range beacons.

TWA announces the completion of 3,000,000 miles of flying with TWA's new Douglas airliners. There are twenty-one of the Douglas planes now in operation by Transcontinental and Western Air, Inc., on its coast-to-coast service and Chicago-New York service and eight more of the planes will be placed in action within a short time.

THERE are 2,297 airports and landing fields in the United States. This includes 702 municipal, 570 commercial airports, 259 Department of Commerce intermediate landing fields, 580 auxiliary fields, 58 army airdromes, 28 naval air stations and 104 miscellaneous fields. California leads in the number of airports and landing fields, Texas is second and Pennsylvania is third.

NORTHWEST AIRLINES, INC., has ordered five new Lockheed Electras from the Lockheed Aircraft Corp., Burbank, Calif. This will bring the total number of Electras owned by this carrier to thirteen.

AIRPLANE DEVELOPMENT CORP., Glendale, Calif., has sold two Cyclone-powered Vultee Transports for corporation service. One was taken by the Superior Oil Company, Los Angeles, while the other was purchased by the United Gas Public Service Co., Houston, Tex. A third Vultee is to go to the American Airways and will be used on the New York-Montreal route.

DURING November, 1934, 15 planes and 82 aeronautical engines were exported from the United States, according to the Bureau of Air Commerce. Foreign purchasers spent a total of $1,634,834 for American-built aviation products during November.

The Curtiss Condor Biplane transport in flight.

William Boeing, president of many aeronautical industries and a pioneer in aviation.

RYAN AERONAUTICAL CO. announces that all production departments have been placed on a full-time basis. An increase of more than 100 percent in factory employment has been made by this company to produce the new Ryan S-T sport monoplane.

EXPORT SALES of the Fleet biplane have been mounting steadily. Consolidated Aircraft Corp., Buffalo, N. Y., announces that 102 complete planes have been ordered by foreign purchasers together with material for 20 planes to be manufactured under foreign licenses. The corporation entered 1935 with orders for 31 complete planes.

AMERICAN AIRLINES' Los Angeles-Fort Worth express revenue showed an increase of 548 percent during the final ten months of 1934 compared with the same period of the previous year.

KELLETT AUTOGIRO CORP. has moved into its new plant at Philadelphia, Pa. The factory has been equipped to produce 100 or more Autogiros per year.

WILEY POST AIRCRAFT CORP., Oklahoma City, Okla., has completed the experimental work on its new plane and is ready to begin its sales campaign. The new ship produced by this firm will sell for $1,692, fly-away factory. The plant now employs 22 men but will include 40 men when the sales force is completed.

PARK HOTEL, Chicago, Ill., is operating four Packard courtesy cars between the hotel and the Chicago Municipal Airport. This service is included in the rental rates.

CONTRACTS have been awarded to the Hammond Aircraft Corp., Ypsilanti, Mich., by the Bureau of Air Commerce, for 15 to 20 of the new planes to be assigned to the Bureau's aeronautical inspectors for use in the field. The new ship is a pusher type with a three-wheeled under-carriage, the latter allowing the plane to be brought to a quick stop by the application of the brakes without nosing over. A low speed of 35 m.p.h. and a high speed of 110 m.p.h. is specified

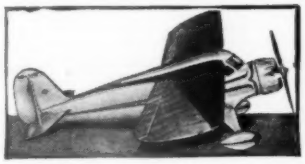
U.S. NAVY, Bureau of Aeronautics, has ordered 84 scout-bombers from the Chance Vought Corporation, East Hartford, Conn. These ships are for replacements in the naval air service and are of typical Vought design, being biplanes with a fabric-covered structure. A 700-h.p. Twin Wasp Junior engine is installed with a Hamilton Controllable-Pitch propeller. These ships, known as the SBU-1, are to be operated from the decks of aircraft carriers.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has developed a new aircraft tachometer that weighs only three pounds. The instrument is an electrical type based on the generated frequency principle in which voltage variations have no effect upon the accuracy. The generator has no brushes nor slip-rings, which is a further step forward in reliability and accuracy.

A striking model of Walter Brown's "Miss Los Angeles."

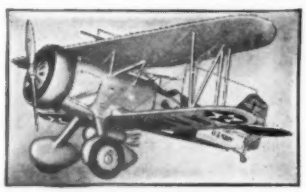
MARTIN BOMBER

Wingspan 35", length 22½", weight 4⅝ oz. Exact scale. Retractable landing gear, rotating gun turret, movable machine guns, special streamline cowlings, two types of 3 bladed propellers—one for flying and one for exhibition with removable motor sticks for flying; rudder and elevator balanced surfaces; new type freese ailerons.
Kit complete, postpaid..... $3.50



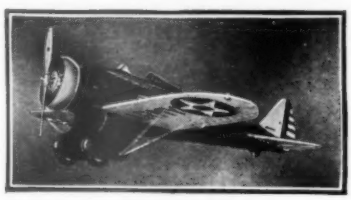
STINSON RELIANT

Wingspan 32 5/16", length 21¼", weight 3½ oz., exact ¾" scale. Here's a plane you'll be mighty proud to own and fly. An exact reproduction of one of the latest 4 passenger cabin planes. You'll find more unusual and different features in this plane than in any other. For example—adjustable speed arresters built into the wings, the movable cabin doors, the complete interior with four seats and control column, and all the other Super-Detail features. Colored in bright contrasting yellow and black.
Kit complete, postpaid..... $2.50



CURTISS GOSHAWK

Wingspan 23⅜", length 16¾", weight 3⅜ oz., exact ¾" scale. You've heard of this beautiful Curtiss Goshawk. Now you can build your own with the most complete kit you ever saw. This snappy little Navy fighter has many more details than you can see in the photo. Everything designed in exact scale of course. Streamlined drag ring specially designed; two detachable blade propellers, and the entire model coated with the new IDEAL high lustre finish, with silver, yellow, red and black coloring. Plenty of material is furnished.
Kit complete, postpaid..... $2.00

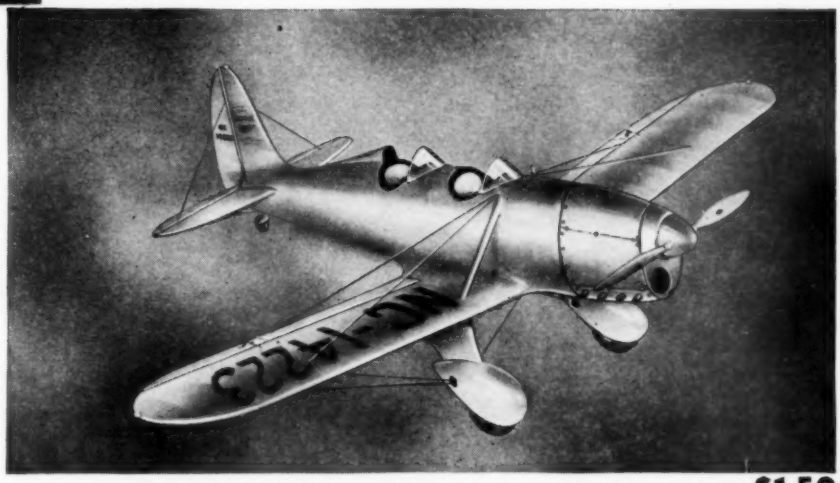


BOEING P-26A

Wingspan 21¼", length 18", weight 2½ oz. Exact ¾" scale. One of the newest, most advanced of all fighting planes. Fast, speedy, with full armament capable of over 240 miles per hour. This flying model is an exact replica of the famous fighter—one that is identical in all but size with its noteworthy big brother. Beautifully colored in olive drab and yellow. All Super-Detail parts included.
Kit complete, postpaid..... $1.75

This Beautiful NEW RYAN S T

Another IDEAL Super-Detail Triumph



Ryan S T Wingspan 22½", length 16½", weight 2½ oz., scale ¾". Complete kit $1.50

AGAIN IDEAL makes model history—with a totally different type of plane—the new and beautiful Super-Detail model of the speedy 2-place sport plane, the Ryan S T.

This graceful model has all the Super-Detail features which mark it as a flying model of the finest quality—the standard for a quarter of a century—and in addition it has certain new and special features that set this plane apart from all others—dual control system which operates in either cockpit; adjustable wing flaps; plans for making an actual working engine—4 cylinders with movable pistons, carburetor and spark plugs.

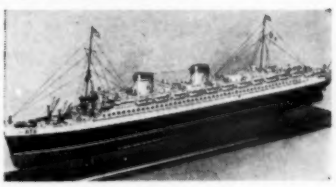
DESIGNED BY FLYING MEN

IDEAL Super-Detail planes have more features. And they are absolutely true for they are designed by real flyers, men who are actually doing things in aviation. That is why IDEAL Super-Detail planes are different; why you really learn the principles of aviation when you build planes the IDEAL way.

Consider the various advantages of IDEAL Super-Detail planes—the first quality kit and materials—the fact that ailerons, rudder and elevator can be set in any position desired for flying and controlled by cables from the cockpit—IDEAL bright high lustre finish—pulleys—control cable—streamline drag ring—exact scale wood wheels—everything an exact duplicate of the big flying planes.

That is why IDEAL is a leader in the field; why you can always depend on a Super-Detail model.

Build the fastest ship afloat, the NEW Super-Detail model—Italian liner REX.



29"—scale 1/32" to the foot

Shaped hull and over 100 metal fittings. 24 cast metal lifeboats; 24 cast stairways, 2 cast anchors; 4 metal propellers; 6 cast bits; 48 metal davits. The Rex comes in beautiful high luster original colors of black, orange, white, red and green; and the kit also contains turned wood parts, printed wood, cement, wood filler, sandpaper, etc. Full sized plans with complete instructions and 7 photographs illustrating the different stages of construction. All the hard work has been done for you.
Kit complete, postpaid..... $6.00

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Canadian Model Aircraft, 3007 St. Antoine Street, Montreal

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Martin Bomber ☐ $3.50 Curtiss Goshawk ☐ $2.00
Boeing P-26A ☐ $1.75 Stinson Reliant Airliner ☐ $2.50
Folder with information ☐ 3c Rex ☐ $6.00

Please print name.....

Address.....

City..... State.....

Airy Chat

(Continued from page 210)

A prompt reply, addressed to the offices of POPULAR AVIATION will be appreciated. We are not in a position to openly disclose the name of the prospective customer at the present time but will do so to all earnest and eligible parties who have a bonafide proposition to make to our correspondent.

* * *

BOEING AIRCRAFT COMPANY, through the courtesy of Richard Rummel, manager of the Publicity Department, makes a number of corrections to Robert J. Fancl's article in the February issue. For those of our readers who studied this article, we offer the following notes for them to mark on their copies.

In the article it is stated that the Boeing XP-9 was equipped with a 600 horsepower Curtiss Conqueror. The XP-936 to which the author apparently refers, was powered with a 550 horsepower supercharged Pratt & Whitney Wasp. The Boeing Aircraft Company also state that they have not developed a Prestone-cooled Boeing single-seated combat plane, as indicated on page 125.

* * *

THE FIRST move ever made by an air transport company to encourage the owners of private airplanes to use its nation-wide facilities and to make private flyers feel at home on its system, was inaugurated by the Transcontinental & Western Air, Inc.

TWA announces that orders have been issued to all TWA field managers, meteorologists and personnel at all cities along its transcontinental route between New York and Los Angeles, to extend all possible service to all visitors. TWA will furnish all visiting birdmen, at its terminals, with free weather information, general flying conditions, routing information and best flying altitudes. Two-way radio service will also be supplied at moderate cost.

To all mechanical staffs at TWA's terminals, instructions provide for expert mechanical help and service and the provision of supplies of fuel and lubricating oils at prevailing rates. The gas and oil can be obtained without cash outlay upon the presentation of a special private flyer's courtesy card which provides for billing on the first of the following month. This is certainly a real service for which TWA is to be complimented.

"The owners of private planes are playing an important part in building up air consciousness in this country," said Mr. Frye, President of TWA, "and we want to cooperate with them in every way by making them feel welcome and at home when they go about the country in their own planes over our routes."

AN INVENTOR is usually a queer bird. Whether it takes a queer man to be an inventor or whether he gets that way by being an inventor is hard to say, but the fact as stated holds true.

The reason that this is mentioned is because we have had a deluge of inventor-visitors during the past month who have submitted many unusual ideas—some good and some poor—to the staff of P.A. But in all cases and without exception, each and every inventor had the hidden idea, amounting to an obsession, that we were in touch with manufacturers and would divulge their ideas to these manufacturers just as soon as the inventors' backs were turned. A highly cultivated suspicion coupled with an ascending ego seems to be part and parcel in this game.

Now, for the edification of all concerned with invention, we have no connections, direct or indirect, with any manufacturer. As a matter of fact we are only interested in such inventions that are in proper condition for publication. If the idea is not patented or protected in such a way that we cannot write a story about it, we are no longer interested in it. It means nothing to us unless we can work a story out of it, and it must be an exceptionally interesting patent to get even this amount of attention. What the manufacturers want, think or do is none of our concern.

And then, to divulge the secret nature of an invention to us gets us in Dutch. You see, we are inventors ourselves, of a sort, and should the inventor show us something that resembled our own brain-child, then he would put us in a very embarrassing position. Understand what I mean?

* * *

GETTING BACK to Minnesota and its aeronautical grievances, we have an interesting letter from G. H. Ruesink, with a newspaper clipping attached. The clipping refers to a court motion to quash information against Sam Kelsey and Clarence Walerius, the first victims to be arrested for flying an unlicensed plane under the new law. The defense is being handled by the Minnesota Aviation Association.

The court motion is based on the contention that the state law is unconstitutional, part of which is based upon the idea of state enforcement of a Federal license.

"It is an impossible situation," said Capt. Lowell, the defense attorney. "A student flyer cannot fly in Minnesota without a Federal license. He must have 25 hours of solo flying to get that license. Consequently, it is impossible for a man to learn to fly in Minnesota. The presumption is, I suppose, that if a man wants to learn to fly he will go to Wisconsin and then come back to Minnesota after he has received his Federal license."

TO ALL of our friends who wish to purchase an airplane, we are opening a new service. Best of all, this service will be absolutely free to intending purchasers of either new or used planes. Just send in a little advertisement stating what sort of plane you desire, or how much you wish to spend, and we'll print it in our new, "Planes Wanted" column. We hope to see this column grow just as the old Barter and Exchange column grew when we started it last year.

* * *

WE ARE in the habit of praising the aviation engine developments that have taken place during the past few years and the outstanding reliability of recent engines, but in the most part we have neglected to shower roses on a branch of the automotive industry that deserves even more praise and which is equally responsible for improved performance and reliability.

This branch of the industry is the oil industry which has consistently improved the quality of gasoline and lubricating oils to the present high standard. Modern high-test anti-knock gasolines have meant a whole lot to the aviation engine while modern lubricating oils alone make long continued, uninterrupted engine operation possible. If we were to use gasolines and oils of the vintage of 1917 on our present engines, they would not do a whole lot better than the wartime engines—if as well. I wonder how long a modern radial engine would stand up on the old "skunk" gasoline and castor oil mixtures.

* * *

TALKING ABOUT engines, makes me think of an outstanding engine article that is to appear in our next issue. This article is an authoritative treatise on 2-cycle engines by Glenn D. Angle, one of our greatest authorities on aviation engines. This article will illustrate many of the different types of 2-cycle engines that have been developed and will prove highly interesting to everyone concerned with aviation.

* * *

THE REPEAL of prohibition has brought about many curious incidents, but I believe that one of the most curious happenings was pulled off at a Chicago airport, the other day. Three men poured the contents of their flasks (high-proof whiskey) into the empty tank of a flivver plane, and under stimulus of the hooch, the little plane took off and circled the field. And the ship didn't stagger, either, which proved that she could take it.

* * *

WE ARE promised an illuminative article on the Macon disaster by an engineer of note—K. Osterblom who wrote an intensely interesting article on airship construction last year. We are, as ever, opposed to further lighter-than-air constructions and we stand pat on this policy.

J. B. R.

A BIG Quarter's Worth!

THE MAY issue of POPULAR AVIATION will be one of the outstanding issues of the year. It will be an issue prized by all aviation fans—both active pilots and those who are ambitious to fly.

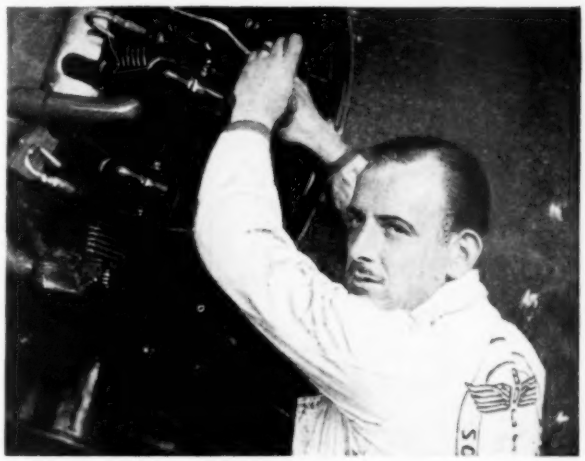
One of the most important engine articles yet published is the article on 2-cycle aviation engines by the great authority on aviation engines—Glenn D. Angle. Then there will be an article on soundproofing methods and materials by Prof. Alexander Klemin, another national authority on aviation.

Our PHOTO PHANS will get a big kick out of the warplane album in the May issue. And our model builders will find a most instructive and interesting collection of notes on gasoline propelled models that have been built by P.A. readers all over the United States. Lightplane fans will enjoy a further construction article by O. G. Corben, and so on, all through the issue.

BUT—as a leading feature that will be of interest to everyone, will be an analysis of the Macon disaster by that able engineer Osterblom who has stress analyzed many of the largest dirigibles and knows what it is all about.

Look for this MAY ISSUE COVER

on ALL NEWSSTANDS APRIL 10th



FIRST YEAR STUDENT JOHN PEACOCK GIVES YOU A PICTURE OF

"What Boeing School is like from the inside"

"Right at the start, let me say this: Steer clear of Boeing School if you're afraid of hard work. This is one place where they sure pile it on.

"Take the course I'm in, for example—Airline Pilot and Operations. That means 7½ hours a day, 5 days a week, for 4015 solid hours.

"But I really enjoy every minute of it! Right now, I'm taking down one of those big Pratt and Whitney Wasps. Next week I'll be putting it together again—and it will have to *sing*.

"We're learning about the business end, too. Airline operations—all the way from organization and personnel to revenue and traffic potentialities. Can you imagine anyone better able to teach you 'operations' than a division of United Air Lines?

"And I'm getting a kick out of flying! Already soloed in the 165 h.p. Boeing 203 Trainer. After 6 more different types, I will be ready to tackle their Hornet-powered Boeing 40 and tri-motored Ford Transport.

"Instrument, or 'blind flying,' is also coming up. And 'landing on the beam'... I can certainly see now why Boeing graduates rate so high with all the companies. A fellow *earns* his reputation here!"

* * *

If you are seriously interested in preparing for a worthwhile career in aviation, write today for full information about Boeing School and its enrollment requirements. Rates from $700 upwards; courses from 9 months to 2 years. Mail coupon today.

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- ☐ Private Pilot
- ☐ Airline Mechanic
- ☐ Airline Operations
- ☐ Airline Technician (Open to Engineering graduates)
- ☐ Airline Pilot and Operations
- ☐ Special Airline Pilot (For Transport Pilots only)
- ☐ Amateur Pilot

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POPULAR AVIATION
608 S. Dearborn St. Chicago, Ill.

Rotorcraft

(Continued from page 243)

The fourth of our needed characteristics, a motor not subject to failure, is a desired feature of all aircraft. It can be supplied in several forms— (1) the multiple motor unit, in which if one motor fails the other or others do the work; (2) the Diesel engine which is simple and therefore surer than the gasoline engine; (3) the electric motor which is simpler and surer than both. Thus, the motive problem need not deter us; by the time an efficient rotorcraft is built a fairly safe motive power will be available.

The fifth (or alternatively the sixth) necessary feature is the crux of the problem before us.

C. F. Zaparka and N. J. Medvedeff, as we have seen, have attempted to vary the resistance of the rotors in flight by pivoting them. This method is subject to the objection that the pivoting mechanism may fail to operate or may cause the rotor to snap off the fuselage while in the air.

Medvedeff has conceived also the idea of telescoping the rotors so that they may be extended to increase the lifting force in taking off or landing. The objection to this type of rotor lies in the difficulty of keeping its telescopic parts rigid.

Either of these objections may be overcome in the future. The writer, however, is of the opinion that the best solution of this problem of varying the lift and simultaneously the resistance to forward flight lies in varying the speed of the rotors and/or the speed of the air current. When structures which will efficiently do this are created by one or a group of the inventors now laboring on the problem, including the writer, we shall see the first successful rotor aircraft. In the opinion of the writer this structure will be built at least within the next two decades.

END

Design

(Continued from page 242)

Finding the thrust at V_{max}:

T = total drag = 375 hp/m.p.h.
$= 375 \times 65 \times 0.78/117 = 162$ lbs.

Induced drag $= D_i = (W/b)^2/\pi q$
$= (W/b)^2(124.5/\text{m.p.h.}^2)$

In this equation b = wing span, ft.

b = span $= \sqrt{RS} = \sqrt{6 \times 153}$
$= \sqrt{918} = 30.3$ ft.

$\therefore C = 30.3/6 = 5.05$ ft. $= 60.6$ in.

$\therefore D_i = (1{,}000/30.3)^2 \times (124.5/117^2) = 9.93$ lbs.

Parasite drag $= D_p = T - D_i$
$= 152.07$ lbs.

Then, at cruising speed, induced drag varies inversely with the square of the velocity, so:

$D_i = 9.93 \times (117^2/93.6^2) = 15.5$ lbs.

Parasite drag varies with the square of the velocity, so:

$D_p = 152.07 \times (93.6^2/117^2)$
$= 97.5$ lbs.

$\therefore T = D_p + D_i = 15.5 + 97.5$
$= 113$ lbs.

Now, solving equations 8 and 9 for E and E_t:

$E = 26C_L/R = 26 \times 0.291/6 = 1.26°$

and

$$E_t = E + a_w[(V_s - V)/V_s][1 - (dE/da_w)]$$

$$\frac{V_s - V}{V} = 1 - \left[\frac{1}{\sqrt{1 + (1075\ T/D^2V^2)}}\right]$$

$$= 1 - [1/\sqrt{1 + (1075 \times 113/37.7 \times 137.5^2)}]$$

$$= 1 - 1/\sqrt{1.17} = 0.074$$

$$1 - dE/da = 1 - (26/R)(dC_L/da)$$
$$= 1 - .075 \times 26/6 = 6.75$$

$\therefore E_t = 1.26 + 2 \times 6.75 \times .074$
$= 1.26 + 0.10 = 1.36°$

In our next article, we will take up further calculations upon the matter of power and make compensation for certain elements that have been in conflict with our desired performance up to this point.

END

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LAWRENCE AIRPLANE MODELS
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Air-Mail

(Continued from page 214)

Oxygen or super-charged cabins must be provided for crew and passengers above 18,000 feet, and must also be provided if any part of a flight is going to be over 14,000 feet for more than 15 minutes. On the other hand, if the passengers all give their consent to staying above 14,000 without oxygen, then the pilot has the privilege of doing so without such equipment.

The question of providing passengers with parachutes is not mentioned in the regulations, but where a pilot flies without passengers he must wear a 'chute. And his compartment must be fitted with a hatch so that he can bail out in a hurry if he has to.

It is hoped to cut down forced landings by requiring all multi-engine aircraft to be capable of continuing flight with one engine out of commission, and in so doing to be able to clear the highest obstruction on the flight by at least 1,000 feet. Single-engine aircraft may be operated in daylight hours only, and only then if the country over which the route lies is suitable for emergency landings. Extensive swamps, woods, bodies of water, and mountains are considered unsuitable. There must be a possible landing place which the plane can glide into from an altitude of 500 feet once during each 5 minutes of flight.

Uncle Sam is also determined not to let any airline operator drown you. Overwater flying will be permitted during daylight hours only and never more than 50 miles from shore. Multi-engine flying boats, amphibians, or seaplanes, or multi-engine land planes having approved flotation for the entire aircraft must be used. And such aircraft shall be capable of landing on the water and remaining afloat for at least 10 hours. Emergency rations, signal flares, and life preservers for each person must be carried.

Requirements for pilots, too, have been tightened up. In addition to holding a transport license, a rating for the type of aircraft employed, and a Scheduled Air Transport Rating, each first pilot must undergo a test every 90 days to prove his ability to fly by instruments under a hood.

That will prevent pilots from simply "boning up" on blind flying to pass their original examination and then forgetting all that they had learned. A pilot must make five round trips before he is authorized to fly over a route and if at any time he should stay off the airway for 3 months, his authority to fly over it is automatically canceled.

A co-pilot is required on an airplane with a capacity of 15 passengers or more, or where the first pilot flies 5 hours or more per day, without a rest period. A first pilot is not allowed to fly more than 100 hours in any one month, nor more than a total of 1,000 hours per year.

Some of the other operating rules are interesting. Sufficient oil and fuel to fly 45 minutes in addition to the time required for the flight to the next scheduled stop must be carried. No flight shall be started when there is the known possibility of the wings icing up. And the final word for every flight is to be left up to the pilot, and shall not be made if the pilot does not feel that it can be accomplished with safety.

At no time, shall an airplane be flown within 500 feet of the ground, the tops or sides of mountains, hills, or other obstructions to flight, except during landings and take-offs. Flying through fogs, clouds, or overcast, is permitted only if multi-engine aircraft is used and a radio receiver is installed and operating. This set must be capable of receiving radio beacon signals and weather broadcasts. At all times, an airplane flying blind must stay at least 1,000 feet above all obstructions, and the terminal where the ship is to be landed must have a ceiling of at least 500 feet.

Close watch over all operations is kept by Bureau officials in Washington. A detailed report must be sent in by the airline company each month.

By the strict enforcement of these new regulations, the Department of Commerce hopes to make American airlines the safest in the world.

END

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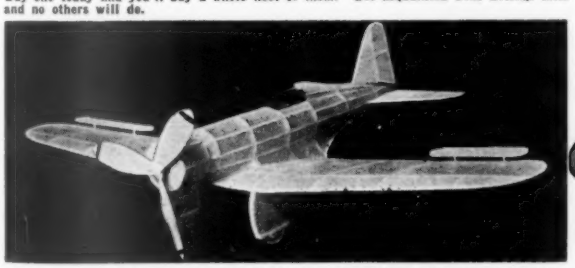

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CURTISS P6-E HAWK

Even exhibition models won't outclass this beauty in appearance—and what a flyer! Every possible detail, wing ribs, stringers, etc., realistically duplicated. Colored yellow and olive drab with distinctive Selfridge Field Squadron markings of black and white, with red striped top wing, and with red, white and blue insignia. Span 23⅝", length 16¾". Complete Kit SF-21B.....$3.25
Kit D-21B (Span 15¾"). No liquids.....75c

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Flies, climbs — beautifully. Span 15⅝", length 13⅞". White. Complete Kit SF-42.....98c
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Covering

(Continued from page 240)

surface after it has dried. This will invariably eliminate the blush. After the fifth coat has dried, the sixth should be sprayed on. Cross spraying will produce better results and eliminate spray marks.

If you prefer a glossy finish, the surface should be sprayed over with a mixture of the following: one-third reducer or thinner, one-third clear dope and one-third colored dope. This will produce a shine, and produce a rubbed effect as well. Again, if your ship is of the super-light variety, do not use more than five coats, put on three of clear, brush on a fourth of semi-pigmented, and spray on one heavy or better, two light coats of color.

If using the spray method for cowling, etc., the metal should be first cleaned, being sure that there is no scum left over from the cleaning operation. Then give one light mist coat of red oxide primer, or some other approved metal oil base primer. Let air dry for twenty-four hours at least, and then wipe off all dust.

You can either use lacquer or Berry Bros. pigmented dope for the finish coat. Berry Bros. pigmented dope can be used with either fabric or metal, and produce wonderful results.

The first coat of either lacquer or dope should be misted on to prevent lifting the primer. Then the second and third can be sprayed on with a light fine sanding between. The finish coat can be two-thirds reducer and one-third color if a gloss is desired.

An oil base finish is not recommended for fabric on account of the difficulty experienced in patching, for the dope will lift the oil paint, and make the surface look like bark on a tree. Neither should lacquer be brushed on for a color coat, as the lacquer will not tighten, will crack in a short time on account of its growing brittle and the solvents used in it will soften up the dope beneath and cause the surface to remain loose. It looks worse than old burlap. If you are going to use lacquer for the color coats, it should be sprayed on, otherwise pigmented dope should be used.

Some of you may prefer a fancy two color combination for a spray finish. This is accomplished by spraying the lighter colored stripes or surfaces first, and then masking them in with Scotch masking tape, and paper if a large surface.

The masking tape comes in various widths, from a half-inch up, in rolls of about a hundred yards. It is a paper brown in color, and the best type resembles creped paper, with the adhesive on one side. When masking in the design, be sure you rub the edges down well, to prevent the gun from blowing the color beneath.

You will find that the tape gathers considerable moisture on damp days and does not stick well. This can be remedied by wiping off the moisture and putting the tape in a rather warm place. Also wipe the surface to be taped.

Now that everything is painted, you are ready to paint in the license numbers. No doubt you have applied for an identification number or have a state number. The federal number takes precedence and should be painted on the upper right and lower left wings, when looking at the ship from the top; the numbers should be at least thirty inches in height, with a stroke of about five inches.

Block lettering is both easiest and best for the amateur. The numbers should be painted on both sides of the rudder near the top. The state number is sometimes placed beneath the federal on the rudder, and some states make use of the first letter of the state, or a state symbol, with the last two letters of the year within, which is painted on the side of the fin or rear fuselage. Therefore see your state inspector as to the style and placing of the state license number or symbol.

END

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1/16x1/8..... 35 for 5c
1/8x1/8..... 30 for 5c
1/8x1/4..... 10 for 5c
1/4x1/4..... 5 for 5c
1/2x1/2..... 2 for 5c

18 IN. SHEETS
1/32 and 1/16x2 8 for 10c
1/8x2..... 6 for 10c
1/4x2..... 3 for 9c

18 IN. PLANKS
1x1 1 for 4c|2x2 1 for 18c
1x2 1 for 10c|2x3 1 for 23c

JAPANESE TISSUE
1 doz., all colors, AA 10c
THINNERS, 1 oz. bot. 5c
REED.....2 ft. 1c
BUSHINGS....1 doz. 3c

BALSA WHEELS
½"..... 3c|¾"..... 4c
1"..... 5c|1⅜"..... 7c
2"..... 10c|3"..... 17c

DOWELS
1/16x6.....doz. 5c
⅛x18.....2 for 5c

WIRE
2 ft. 1c — 25 ft. 10c

INSIGNIA SHEETS
21 and strips..... 5c

WASHERS
1 doz. ⅛ and ¼..... 1c

PROPELLER BLOCKS
½x ¾x 6.....6 for 5c
⅝x1 x 7.....2 for 5c
¾x1 x 8.....2 for 5c
¾x1¼x12.....1 for 4c
1 x1½x12.....1 for 7c

20 IN. FLYING PLANS 10c—3 for 25c
Texas Sky Chief, Sparrow Hawk, Gee-Bee, Boeing Trans. 247, Spad Chass., Vought Corsair, Curtiss Swift L. W., Waco Cabin Biplane, Douglas Dolphin, Boeing P-12-F, Fokker D-VII, S.E. 5, Goshawk.

THRUST BEARINGS
Small, doz.....10c
Large, doz.....15c

RUBBER
1/16x1/16.....18 ft. 5c
1/8 flat.....15 ft. 5c

SHEET CELLULOID
6x8.... 5c|12½x16..20c

CELLULOID WHEELS
⅜"..pr. 5c|1¾"..pr. 10c
1"..pr. 7c|1⅞"..pr. 17c

WOOD VENEER PAPER
20x30.....1 for 10c
Sandpaper, package... 5c
Prop. Shafts, dozen... 8c
Nose Plugs, dozen...10c
Model Pins, package.. 5c

BIRCH WHEELS
½"..... 2c|¾"..... 3c
1"..... 4c|1½"..... 5c
2"..... 10c

SHEET ALUMINUM
.005 in. thick, 15c sq. ft.
.010 in. thick, 20c sq. ft.

CLEAR DOPE
1 oz.....5c ½ pt.....30c

COLORED DOPE
1 oz. bot., all colors. 5c

CLEAR CEMENT
1 oz. bot..... 5c
2 oz. bot.....10c
⅛ pt. bot.....35c

MACHINE-CUT PROPS
5"..... 5c|6"..... 6c
7"..... 7c|8"..... 8c
10"..... 10c|12"..... 12c

BAMBOO
1/16x1/16x12..36 for 5c
1/16x1/4x15.... 1 for 1c
Dozen 8c

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Super-Ace

(Continued from page 244)

installed one in each wing. They are held in place by three steel straps, two on the bottom and one across the top of the tank. The top strap has a small turnbuckle brazed in it so this strap is adjustable. In making up the bottom straps be careful to make them just the right length so the tank will not protrude below the bottom curve of the wing. The strap nearest the root end attaches to the root end fitting bolt, both at the front and rear.

The gas tanks are made of terne plate. This is a lead-coated material that will not corrode nor rust and neither tin nor galvanized steel should be substituted for it. The filler-neck is the same as used on the Model "T" Ford radiator. The drain fitting is cast brass and is soldered to the tank.

When the tanks are installed, lay strips of tape or felt between the tanks and straps, otherwise the shifting of the tanks might rub a hole in the metal and you would have to uncover part of the wing to make repairs. See that your tanks are well fastened and held tight.

I do not think any time will have to be spent on the aileron details for they are very clearly drawn upon the plans, so we will move on to the tail group drawing.

The entire tail group is constructed of steel tubing and later covered with fabric the same as the wings. You will have quite a little welding to do so if you are not a real good welder it will pay you to get in touch with someone who will do the welding for you, for it is very important that all welds are just right.

First, cut and fit all of the tubing as detailed, make up the ribs for the elevators and rudder as shown. These are made out of sheet steel and formed on a tinner's "break," the ends are cut out to the size of the tubing to which they are welded. It will be a good idea to lay the tail group out full size on a wood bench or floor and fit all the pieces to this layout, in other words, it is to be a temporary jig, nails are driven in around the tubing to hold it in place, in the same manner you would use when building a model plane.

All joints are tack-welded in place, then welded later, care should be taken to keep the different units from warping during the tacking and welding, however, if they do warp they should be straightened and lined up before the cover is put on.

You will note from the drawing there are several small tubes welded onto the leading edge and the rear spar of the stabilizer. The front tubes are for attaching the stabilizer to the fuselage while the rear ones are for the brace wires and elevator hinges.

A hole is first drilled through the stabilizer tubing and the small tube is then inserted into the hole and welded at each end. It is a good idea to make the small tubes about one quarter of an inch longer than desired as it is much easier to weld the ends. After the welding is done the ends are cut off to the length shown on the drawing.

When making up the elevators and rudder it is necessary that the hinges be made up and slipped onto the spar and into their proper places as detailed. This also applies to the hinges, collars and control horn details. When welding the control horns, care should be taken to have them 90 degrees to the line of control surface. You will note that the horn is made up of .125 steel and is welded onto a tube sleeve having a fish-cut mouth at each end. This is then welded to the spar with a fish-mouth weld.

All steel used in the construction of the tail group as well as the tubing is S.A.E. 1025 steel and no other kind or grade of steel should be used.

The brace tubes shown must be heated to a cherry red before bending or flattening as detailed, the gussets are welded on after the tube is bent.

In the next article I will give you the plans for the fuselage and the fuselage fittings, so have plenty of good hack saw blades on hand for there will be a lot of cutting and fitting to do.

END

Meteorology

(Continued from page 228)

north of the Mormon Range. Come down for three hours and then you can go on at 7,500 feet." Such information about possible safe altitudes is just as important as the more general information about good and bad areas.

To arrive at a forecast of the conditions, the meteorologist assembles the reports from the various stations throughout the country and first charts the pressure areas. This helps him in determining the speed and direction of movement of the air masses.

Next, he outlines the air masses themselves so that he can calculate, from where they lie and in what directions they are moving, when and where they will meet, with the resulting warm or cold air fronts. With this information he can forecast precipitation, cloud formations, and ceilings from a study of humidities and temperatures, and wind velocities and directions from air-mass speeds and pressure area locations.

By means of this accurate forecasting, airplanes starting from the west or east coasts can be routed in between, and sometimes over, the various fronts so that the best available weather conditions will be encountered.

Or in extreme cases, pilots are directed when and where to land for a few hours to escape moving areas of turbulence. As the system is further perfected, meteorologists estimate that, instead of the present limit of about forty-eight hours, it will become possible to make accurate general predictions as far as seventy-two hours in advance.

END

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High-Lights

(Continued from page 232)

his future speed dashes a flight around the world at the equator . . . Wiley Post is getting ready for a stratosphere flight across the country . . . Secretary Dern has ordered a series of stiff tests for the 1,228 Army Air Corps pilots in order to eliminate the "swivel chair" fliers.

Rep. J. Mark Wilcox (D., Fla.) has introduced a bill asking $190,000,000 for 10 military air posts and 3,000 planes . . . According to present plans the *L.Z. 129*, "big sister" of the famous *Graf Zeppelin*, will make its maiden voyage to Lakehurst, N. J., in mid-July . . . Orders had been received at Moffet Field for the *Macon* to cruise to the Hawaiian Islands in May, just prior to its recent crash . . . Anson Lisk, 16-year-old high school student of Beverly Hills, has been granted a pilot's license.

Mrs. Peter Holland, "flying-mother" who stole away from her family and went to Europe via the *Graf Zeppelin*, has been making an air tour of Illinois in behalf of a pension bill for the aged . . . Postmaster General Farley has submitted a statement to the House and Senate Post Office Committees to the effect that the heroic but bitter experience of the army flying the mail cost 12 lives, 5 injured and $3,767,355.

Two of America's pioneer pilots, Beckwith Havens and Richard Depew, Jr., who have been flying since the days of the old pusher-planes, are still active in the air industry and may be seen daily at Roosevelt Field, L. I.

Havens was one of the early birds with the first Curtiss team of exhibition flyers . . . Depew tested the first air-mail plane bought by the United States and has flown 113 different types of airplanes, three types of Autogiro and a glider.

THE LADIES, GOD BLESS 'EM! Petite Maxine Howard broke all records for the 1,150-mile trip from Cleveland to Miami averaging 240 miles per hour all the way . . . Last October Mrs. Howard flying "Mr. Mulligan" built by hubby Ben, flew the 318 miles between Cleveland and Chicago in 76 minutes, an all-time record . . . Marthe Richard, famed war spy and "Skylark" pre-war stunt flier of France, is learning to fly again at Guayancourt air field.

Laura Ingalls is the first woman to secure the coveted United States Department of Commerce scheduled air transport rating, which is the official mark of approval for "blind" flying . . . In May, 1930, Miss Ingalls set a woman's world record with 344 loops, eventually increased to 980 . . . Adoree Neville, stunt flier who once fell 3,000 feet in a plane and escaped unhurt, was painfully injured recently when her BED collapsed . . . Mrs. Ulysses Grant McQueen, long-distance flyer, broke her ankle while picking wild flowers . . . Better stick to flying, girls!

Wonder what the investigating committee will find out about the Macon disaster? Will they find definite and constructive information on the frailities of dirigible hull members or will it be just another case of passing the buck to defend important officials involved in the matter?

TAPS: Following an operation performed in Munich, Dr. Hugo Junkers died on his seventy-sixth birthday . . . Pioneer builder of all-metal airplanes, Dr. Junkers would have celebrated the twenty-fifth anniversary of the day when he was granted a patent on his first metal monoplane, when death claimed him.

END

Propellers

(Continued from page 230)

When the investigations were started, a collection was made of propeller blades that had failed. In several cases, there were clean breaks several inches from the tip. These breaks, when examined closely, had a definite, fairly uniform character.

With his vibrating equipment, Lieut. Couch has been able to duplicate such breaks almost exactly. In fact, with propellers of identical design, there is scarcely a visible difference between the break that was manufactured in the laboratory by prolonged vibration, and the one that occurred in service, even to the distance of the break from the tip, and the shape of the broken edges.

Tests have shown that the most troublesome type of resonant vibration is the one in which there are three nodes along the blade, with either a node or loop at the hub center line. A propeller under test has been broken by 1 hour and 10 minutes of one-node vibration at a resonant frequency—that is, a frequency at which the vibrating weight was in step with a natural vibration period of the propeller.

In another test, a crack appeared in 25 minutes when the blade was vibrating with three nodes. It was more than 7 hours before the crack developed into a complex break. This particular break was an almost exact duplicate of one that had occurred in a propeller after it had been flown 110 hours on a plane.

Another peculiar property of vibrating propeller blades was uncovered by the research. If you were to hold your hand on a vibrating blade near one of the nodes, your hand would be drawn over the surface in a circular path. Grains of sand, in a like manner, do a round dance. It was found that the metal, at any given point in this area, does not move back and forth over a path of fixed direction, but over a path that swings about constantly.

To make this action more prominent, a test blade was given a coat of black paint and then covered with a network of white dots and circles. When the blade is vibrating, the dots look like rods and the circles like tubes. By watching them, the peculiar swinging motion in some areas is apparent. Probably this twisting action near nodes has much to do with the failure of the metal in the propeller blades.

Perhaps you are wondering how an engineer can determine whether the hub of a propeller is stationary—is a node, in other words, or whether it is part of a loop. He simply holds two elec-

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tric wires, connected to a battery and light in series, so that the tips of the blades touch them on their upward stroke. If the light glows, he knows that both blades have moved upward at the same time to complete the circuit, and that there is a loop at the center line of the hub. If there is no light, there is a node.

When one wire is held above one blade and the other below the second blade, a node at the center will cause the lamp to light, while it remains dark for a loop. In other words, a loop at the center causes the blade tips to act like the tips of a bird's wing, while a node at the center makes them behave like the ends of a teeter board.

From these investigations has been developed a routine method of testing airplane propellers to determine whether or not they are safe. For example, it was desired to learn whether a certain propeller was safe for use on one of the new B-10 bombardment airplanes. This was a controllable-pitch propeller, which meant that the angle of the blades could be altered to suit flying requirements and engine speeds.

The standard vibration test developed by Lieut. Couch was applied, with the blades set at various angles. It was determined eventually that there was a dangerous resonant vibration condition when the propeller blade was set at a pitch of 35 degrees, and the vibration frequency was 8,880. This frequency would be produced by an engine speed of 1,973 r.p.m., gasoline explosions in the cylinders being the basic cause of vibration. However, the engine's best high speed was 1,950 r.p.m., which was just 22 revolutions from the danger point. And so it was suggested that the propeller tips be thinned down a little so that the critical vibration period would be 9,000 vibrations per minute, which would provide a sufficient margin of safety, of 50 engine revolutions per minute. The airplane could then be flown at desired speeds with safety.

All airplane propellers in the Army Air Corps are being tested to determine whether they are dangerous from a vibration standpoint. If they are, they will be either reshaped or replaced. Manufacturers are adopting the tests, and commercial aviation propellers doubtless will be subjected to them, with the eventual result that the number of "inexplainable" air disasters will be reduced.

Lieut. Couch has suggested that such tests be applied to all experimental propellers of radically new design, before the final cut is taken in shaping the blades, so that dangerous conditions can be corrected with ease. Such corrections are made principally by removing or adding metal in certain places to change the natural vibrating period of the propeller.

Now that much of the preliminary laboratory work has been done, even though it still is in progress at the time of writing, Lieut. Couch is developing ways of studying vibration of propellers in actual use. This looks, at first inspection, like a hopeless task. An engineer cannot sprinkle sand on a blade that is spinning almost 2,000 times a minute, to find the nodes. Neither can he apply the electric-light test.

But Lieut. Couch is seeking the solution with the aid of delicate electrical equipment; he is using a harmonic analyzer, which was developed by a radio manufacturer. In preliminary tests, an instrument was mounted in the airplane, with its magnetic pick-up located near the hub of the propeller. On the propeller blades, near the hub, were fastened small permanent magnets. The movement of these magnets past the oscillograph pick-up set up small electric currents that were recorded as curves on photographic paper. Analysis of the curves would provide a picture of the way in which the propeller was vibrating. The plane of the vibrations and the general characteristics of the orbit tells the story.

The chief difficulty with the first tests with this equipment was that the vibration of the magnets by the propeller shook most of the magnetism out of them. Further tests will be made with magnets of a more permanent nature.

Exhaustive studies with the harmonic analyzer and other laboratory instruments doubtless will uncover further important facts about the present more or less mysterious behavior of propeller blades which have a weakness for dancing. A knowledge of how to prevent propeller failures arising from resonant vibration will be of immense value to both commercial and military flying.

END

Aero-Sportswoman

(Continued from page 228)

ing, on the effect flying has on a pilot's nervous system, may prove a valuable contribution to the industry.

They have both taken out student permits and soon will be able to qualify for licenses themselves. It will be interesting to get their opinions on the effect flying has on different types of individuals, and the strain that is put upon the human system by various types of flying. Some of us imagine that we do, or do not, feel any reaction to flying, but Drs. Gross and Kittredge have the scientific knowledge to determine the extent of these strains . . . especially upon the woman flyer.

END

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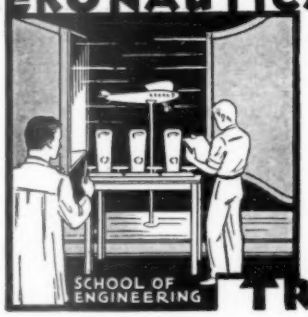

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Engineer

(Continued from page 234)

dum out to the manufacturers until the end of the second week in December!

To return to our original questions—will you please explain to us and to the industry, how anyone can get a new design completed and approved when it is necessary to start an analysis over again, every time it is three-quarters completed, just to satisfy your desire to show how much power you have? Or were we right, originally, in assuming that you are trying to make progress impossible, and so to kill the industry?

END

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Model Dept.

(Continued from page 247)

model-airplane dope to fasten it to the outer edges. Stretch tissue as tightly as possible to remove all wrinkles. When edges have dried, apply coat of water to tissue. When all water has dried completely, tissue will become taut. May we suggest that you pin wings, elevator, etc., and such upon a flat surface to keep from warping.

Next, apply coat of clear dope to all surfaces. Now apply colored dopes. Note, do not try to cover frame when it is completely assembled. Wing, elevator, etc., are cemented to fuselage after they have been completely covered with tissue.

ASSEMBLY

The wing, elevator, rudder, landing-gear, etc., can now be cemented in their correct positions. The elevator is braced with two struts running on either side of fuselage outward to the elevator. The rudder is braced with two wire struts (thread) one running downward on either side to the elevator. The landing-gear may next be cemented in position. In cementing the wing to top of fuselage make sure all struts line up properly.

Small details, such as gas caps, brackets, radiator, etc., are clearly explained on the plan. All rivets and trade marks may be reproduced on the black part of fuselage with white showcard color. Use ordinary pen to apply same.

Two types of propellers are shown on the plan, the scale propeller is carved and sanded to shape and given three to four coats of clear dope to give it a natural wood finish. The flying propeller, which has fiber blades, has less r.p.m. in order that the model can fly a greater distance.

Plenty of patience is required to construct the propeller. It should be carefully adjusted until the best results are obtained. Three or four strands of ⅛" flat rubber are sufficient to fly the model.

With the model completed, we next start making adjustments and balancing the model for flight. All of the parts should be checked over and repaired before flying.

To balance the model, a small amount of weight can be added to the nose. In testing the model, it is advisable to glide it into tall grass to prevent any damage.

END

Fanshier

(Continued from page 224)

and to this end, the aviation people are beginning to discuss the possibility, feasibility and desirability of really getting aviation into the nation's educational system—in other words, getting aviation into the schools.

High authorities in educational circles recently have gone on record as favoring some plan (details yet to be worked out, of course) for getting intelligent study of aeronautics and all that it implies before the students, at least in some minor fashion, if in no other. With this more or less favorable background, wouldn't it seem to be up to aviation interests to give some real thought to the conscious direction of the nation's youth into channels of interest in this subject?

Ways and means of handling this, whether through some text-book means, school lectures, parent-teacher organizations, the National Education Association, or otherwise, ought to be given early consideration by all concerned.

It should be the concern of every person even remotely associated with aviation, to see that the industry does everything in its power to put the United States in invulnerable position as to air-power from the national defense standpoint. If ever there were a question worthy of lobbying with legislators, here is one. There are lobbies and more lobbies, and these lobbies are receiving much respect and attention from congressmen. Aviation should make sure that the national law-makers do not have a chance to forget flying defense, on a grand scale.

The subject of research and development of materials and processes, of course, is one in itself. Those who have not followed closely the recent developments in science in many fields do not appreciate the situation. There have been many recent discoveries of new products and new processes which are of great potential interest to aviation, even though no direct connection has been established. Lighter, stronger, tougher substances and ways of making them are among these discoveries. They await mainly capital and a chance for extensive experimentation. Motor fuels and lubricants of increasing possibilities in performance are among the most important of the developments to be made, particularly in lubricants which are now rather behind the schedule.

END

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Propellers

(Continued from page 238)

chords moreover are assumed to lie in the same plane.

The stresses thus calculated may be a little too high, but on the safe side, at any rate.

To simplify the problem still more, the neutral axis of each cross-sectional area, which, of course, passes through its center of gravity, is assumed to be *parallel* to the chord of each cross-section. In reality this is not so, since, in order to maintain the axis as neutral, the moment of inertia above the axis should equal the moment of inertia below the axis. In bending, the part above the axis will be in compression, while the part below the axis will be in tension.

Now, since we have diminished the distance from the "neutral" axis to the extreme fiber, the part below the axis will have a greater section-modulus than with the true neutral axis. Consequently since the stress equals the bending moment divided by the section-modulus (the section-modulus equaling the moment of inertia of the area divided by the distance to the extreme fiber), the tensile stresses in the portion of the blade below the neutral axes will be about *30% too low.* The calculated tensile stress then will have to be multiplied by 1.30, which brings the result near to actuality.

Twisting forces are entirely disregarded and it is assumed that the resultant air forces all pass through the centers of gravity of the corresponding cross-sections. The problem then is reduced to finding the effects of the airload and of centrifugal forces on a cantilever beam as shown in Fig. 4.

To find the stresses due to the air forces is a simple matter and since it is desirable to get the deflections also, the usual graphical method is advocated. The first thing to do is to plot the *load grading curve* for the length of the blade drawn to a certain scale. *The vertical shear* can be derived directly from this curve. The airload is then graphically integrated, and the values of the divisions are used as forces in the force polygon, from which the bending moment curve is derived. The moment curve is then corrected for varying moments of inertia with reference to an adopted moment of inertia and the thus-corrected moment area is integrated; the values of the divisional areas being used as before, as forces in other force polygon, from which the elastic curve is derived. The elastic curve shows the deflection for any point on the beam. This method is well known and those familiar with it can get shear, bending moments, stresses and deflections almost automatically with very little mental effort.

In order to find the stresses due to centrifugal force the blade is divided into sections of any convenient length, say 6″ or 1 ft. The cross-sectional areas at these points are then determined. For R.A.F.-6 or Clark-Y series a formula is usually available; if not, the area can be found by using a planimeter.

The centrifugal force CF per foot radius is given by the following formula:

$$CF = \frac{(12) \times r \times A \times W}{G \left[\frac{2\pi \times \text{r.p.m.}}{60}\right]^2}$$

in which r = the radius in feet at which the cross-section for which the centrifugal force is being calculated, is situated.

A = the area in squ. in. of that cross-section.

W = the weight of the material per cu. in.

G = acceleration due to gravity = 32.2 ft. sec.^{2}

The factor (12) denotes the length in inches of the section under consideration. If we make these lengths 6″ then (12) will have to be changed to (6).

Thus, supposing a portion of a propeller blade 12 inches long to have a cross-section nearest the blade-tip of 5 sq. in. area, this cross-section being situated at a radial distance of 2.5 ft. from the center of the propeller, the propeller turning at 2,000 revolutions per minute, and the weight of one cubic inch of the material being 0.1 lb. (aluminum alloy, for instance), then the centrifugal force acting at that cross-section would be:

$$CF = \frac{12 \times 2.5 \times 5 \times 0.1}{32.2 \left(\frac{2 \times 3.14 \times 2{,}000}{60}\right)^2}$$

= 20,400 pounds.

The centrifugal force per radial division of any desired length is calculated in a similar manner for all divisions (or sections), and the forces obtained are plotted to a certain scale against the radius of the blade, as shown in Fig. 5. If the scale of the radius is in ft., and the forces are laid off in 4,000 lbs. increments, each square of the graph then represents 4,000 pounds per radial foot.

The curve connecting the extremities of the ordinates encloses the CF area. The total centrifugal force acting at a given section is represented by *the area from that section to the tip,* shown shaded in Fig. 5. Now, if the shaded area contains 7½ squares to the right of the ordinate 2.5 ft. radius, the total centrifugal force acting at that section is 7.5 × 4,000 = 30,000 pounds. Since the cross-sectional area at this radius is 5 square inches, the tensile stress is 30,000/5 = 6,000 lbs./sq. in.

The above-outlined method is simple and gives results of sufficient accuracy for all practical purposes. And yet, the

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stresses found by this method *are far too high*, for the simple reason that the *effect of the deflection* of the propeller blade has been ignored. It has already been pointed out that the centrifugal force has a tendency to straighten the blade. The bending moments on a blade in a flexed condition are counteracted by the bending moments induced by the centrifugal force. This is illustrated in Fig. 6.

The reverse bending moment at section 2 is due to the centrifugal force at section 3, this bending moment being equal to $CF_3 \times f_2$, where CF_3 is the centrifugal force at section 3 and f_2 is the difference in deflection between section 3 and section 2. This difference can be taken directly from the elastic curve, with due regard to the scale. In the blade flexed as shown in Fig. 6 the cross-sections have rotated about their gravity axes in the direction of the arrow a.

The bending moment due to the centrifugal force however acts in the *reverse direction* as indicated by the arrow b, that is to say the bending moment due to the air forces is counteracted by the bending moments caused by the centrifugal forces. It is obvious that the resultant bending moment is equal to the difference between the centrifugal moments and the airload moments, and therefore very much less than the original moment due to the airload, and that the stresses are thereby decreased accordingly.

If the two bending moments should be equal in magnitude they will neutralize each other by reason of their opposed directions and the bending stresses in the blade then would be nil. This, of course, would be an ideal condition.

Thus, in order to find the exact stress prevailing at any section, we first find the bending moment due to the airload, then the bending moment due to centrifugal force, and the *algebraic* sum of both. From this, by dividing by the section-modulus, we get the actual tensile and compressive stresses. *To these tensile stresses then should be added the tensile stresses due to direct centrifugal force*, and this gives us the maximum tensile stress in the outer fiber of the blade (at the chord side). Compressive stresses are usually completely eliminated. It will be seen that the maximum tensile stresses found in this manner are very much less than would be the case if the deflection were not taken into account.

This condition can be utilized to advantage by giving the blades a design-inclination forward whereby the reverse bending moments due to centrifugal force will counteract the airload moments at *any* speed of the propeller, especially in the case of thick propeller blades of great rigidity which show little or no deflection.

The question of vibration in propeller blades is an important one and we have already mentioned some of the causes. Other possible causes are inequal weight of the propeller blades, differences in the angles of both blades, periodic variations in the airloads due to unsymmetrical fuselage or proximity of other parts, irregularities in the air current through which the plane travels, or installing the engine at an angle so that the propeller is inclined backward with reference to the line of flight. In this case, of course, the angle of attack will be greater on the down stroke of the blade than on the up stroke, which will cause a periodic fluctuation of the airload.

To safeguard against the effects of vibration the propeller should be designed for *fatigue stresses*, for fatigue strength is considerably below the elastic limit.

The strength of a propeller can be investigated by subjecting it to *destructive whirling tests*, at twice the design brake horsepower for a minimum period of ten hours, in the case of metal propellers, or at 50% design-power overload in the case of wood propellers. The only reliable test, however, is actual use, in which the propeller is exposed to a variety of conditions not obtainable by whirling tests.

END

Air Maps

(Continued from page 219)

be made. The small changes are usually so well concealed that it is impossible to detect the erasure with the naked eye. Material that is to be eliminated is shaved off with a razor-like steel knife. Replacements are carefully stamped in with the proper color.

The new sectional maps that are now being flight checked are New York City; Cincinnati, Ohio; Kansas City, Mo.; Tulsa, Okla.; Seattle, Wash.; Portland, Ore.; San Francisco, Cal.; Norfolk, Va.; Charlotte, N. C.; Savannah, Ga.; and Mount Shasta, Cal.

John S. Wynne of Fairfax, Va., is in charge of the marking and mapping for the Bureau of Air Commerce while W. T. Miller of Port Orange, Fla., is chief of the flight section. Mr. Miller is a former chief of the airway patrol. These two men have charge of the five flight-check crews that have received their maps for checking.

The crews and their assignments are as follows: C. A. Charles of Hulmeville, Pa.; W. J. Mackenzie of Washington, D. C.; and T. R. Hurlbut of Hot Springs, Ark., who are at work on the Kansas City map; T. E. Flaherty of Little Rock, Ark.; William J. Muldowney of Boston, Mass.; and M. M. McGuire of Laurinburg, N. C., who are checking the Tulsa, Okla., map.

E. M. Haight of Fort Myers, Fla.; D. K. Albertson of Williamsport, Pa.; and W. T. Jamieson of Jacksonville, Fla., are working on the Charlotte, N. C., map. Joseph F. Read of St. Louis, Mo.; E. H. White of Baltimore, Md.; and H. D. Stiles of Dayton, Ohio, are checking the Cincinnati, Ohio, region.

Besides these flying men, the Bureau's technical map-making forces have been added to to the extent of 12 cartographers, 53 draftsmen, 10 lithographic draftsmen, 2 photographers and 2 pressmen.

The new sectional airway maps may be obtained upon their completion by applying to the Bureau of Air Commerce, Washington, D. C.

END

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⅛x⅛.....5 for 1c; 35 for.... 5c
⅛x¼.....2 for 1c; 12 for.... 5c
¼x¼.....1 for 1c; 6 for.... 5c
¼x½.....1 for 3c; 3 for.... 5c

Balsa Sheets, 18 In.

1/32x2.....5 for 6c; 10 for....10c
⅛x2.....1 for 2c; 6 for.... 8c
¼x2.....1 for 4c; 3 for.... 8c

Balsa, 18 In. Planks

1x1..... 2 for.... 5c
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Propeller Blocks

¼x¾x5.....1 for 1c; 6 for.... 5c
⅜x1x7.....1 for 2c; 3 for.... 5c
¾x1x8.....1 for 2c; 3 for.... 5c
⅞x1¼x12....1 for 3c; 2 for.... 5c
1x1½x12....1 for 6c; 2 for....11c

Reed

3 ft..... 1c

Wooden Wheels

½", pair..... 1c
⅝", pair..... 2c
1", pair..... 3c
1⅜", pair.... 4c
1⅝", pair.... 8c

Nose Plugs

2 for..... 1c
12 for..... 5c

Thrust Bearings

1c each; doz. 8c

Bushings

1 doz..... 2c

Bamboo

1/16x15, 20 for 3c
40 for..... 5c
1/16x¼x15, 2 for..... 1c

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20"x30", 1 for 9c; 2 for.....15c

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1 doz., all colors.....16c

Clear Dope
2 oz..... 8c
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Rubber Motors
1/16 square, 20 ft. for..... 5c

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¼ & ⅜, doz. 1c

Clear Cement
1 oz..... 5c
2 oz..... 8c

Sheet Celluloid
2x6..... 3c
6x8 4c; 12x16 18c

Celluloid Wheels
¾", pair..... 5c
1", pair..... 6c
1⅜", pair.... 8c
1⅞", pair....15c

Thinner, Best
1 oz..... 5c

Colored Dope
1 oz. 5c; 2 oz. 8c
All colors.

Sandpaper
Package..... 5c

Wire
3 ft. 1c; 26 ft. 10c

Aluminum Leaf
2 sheets for.. 1c

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9" Plans, each 5c
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Waco Biplane, Texaco Sky Chief, Spad Chasseur, Swift Curtiss, Sparrow Hawk, Vought Corsair, Gee Bee, Ott Hydro model.

Send 3c stamp for "Helpful Hints for Model Builders" and catalog for other bargains. This booklet FREE with all orders.

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5 1/4" x 1/4" x 24" balsa strips
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5 1/16" x 2" x 24" balsa sheets
1 1/4" x 2" x 24" balsa sheet
1 large jar of banana liquid
2 jumbo tubes of cement
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This merchandise is first-class stock, and if you are not satisfied I return your money.

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BOOST AVIATION, Box No. 2665, Honolulu, T. H.

Air Cadets

(Continued from page 218)

certificate from the registrar of your college if you have had two years' college work.

If there is nothing in your application to disqualify you, you will receive notification when and where to report for examination. You travel there at your own expense, take the physical and then, if necessary, take the mental examination and are notified later, if you pass or fail.

If you pass and are in a high enough priority status you receive appointment. You are sworn in and agree to serve for three years as a Flying Cadet or an officer unless you are discharged, or the Army has no funds to keep you on.

THE FLYING COURSE

THE man who does receive appointment as Flying Cadet is transported at government expense from his home to the Air Corps Primary Flying School at Randolph Field, fourteen miles from San Antonio, Texas. While a Flying Cadet he receives $75 a month salary, free uniforms and a generous mess allowance. The course at the Primary School is eight months in duration. Classes start every four months.

The course at Randolph consists of primary and basic flying training and ground training. All students must take both air and ground training, the latter consisting of instruction in airplane engines, navigation, machine guns, radio, theory of flight, repair of aircraft structures, etc.

Primary flying training is given in comparatively light planes and the student is taught to fly an airplane. Then he advances to the basic stage where he is placed in a larger plane and taught to fly a military-type airplane. After eight months he is transferred to the Advanced Flying School at Kelly Field, also near San Antonio, Texas, where for four months he flies military airplanes of all types (bombers, attack, pursuit and observation planes) on actual military missions. His ground-school work now deals with real military air and ground subjects.

At the end of the year he has had about 250 hours in the air, is a fine air pilot and has had a lifetime of experiences. Those who flunk the course are sent back to their place of enlistment at government expense and given an honorable discharge.

To give an idea of the proportion of those who successfully complete the course and those who fall by the wayside, here are some late figures.

	Entered Primary School	Completed Flying Course
Class of March, 1933	150	62
Class of July, 1933	142	56
Class of Oct., 1933	74	30

Entered in 1933—366; graduated in 1934—148.

AFTER GRADUATION

UPON graduation from the complete one-year course, cadets formerly were given a commission as Second Lieutenants in the Air Corps Reserve and placed on from one to two years' active duty in a regular squadron. At present, however, they are placed on active duty in such squadrons but as *Flying Cadets*. That is something new and has been in effect since March, 1933.

It appears probable that most of these Flying Cadets on active duty in the squadrons will be commissioned in the reserve after their one year's squadron duty as cadets and will then be placed on another year's active duty as officers. In March, 1934, the first batch of graduate Flying Cadets on squadron duty will have completed one year of such duty and their future status will then be known.

There is a difference in pay which makes the differentiation between officers and cadets important. A Second Lieutenant, reserve or regular, of the Air Corps draws the following monthly pay on active duty:

Base pay	$125.00	Minus a temporary 5 percent cut in common with all federal pay.
Flying pay	62.50	
Subsistence allowance	15.30	
Total	$202.80	

The above in addition to quarters for himself or his dependents; a house or

(Continued on page 266)

$1.50 THOMPSON SUB MACHINE GUN $1.50

Complete kit with machined barrel, magazine, all necessary hardware and full size working plans...$1.50
Colt calibre .45 automatic pistol..... 1.00
Colt calibre .25 automatic pistol..... .50
Colt calibre .22 automatic pistol..... 1.00
Savage calibre .32 auto. pistol with mach. barrel... .75
Luger auto. pistol cal. 9 M/M W/4" mach. barrel.. 1.75
Colt single action Frontier revolver with machined cylinder, rod ejector and 4¾" barrel..... 1.45

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( ) Htg. and Ventilating Engineering
( ) Radio Engineering
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( ) Highway and Bridge Engineering
( ) Air Conditioning
( ) Landscape Engineering
( ) Civil Engineering
( ) Mathematics

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( ) AIRCRAFT DRAFTING
( ) Topographic (Maps)
( ) Patent Office Drafting
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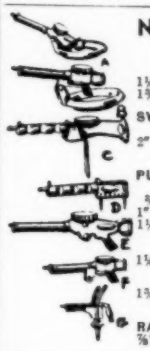

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DUMMY RATCHET GUN
⅞" long.....10c
Postage 3c Each

Die Cast Bombs and TORPEDOES

13/16" 8c
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Something New
1" dia., 9 cyl. 30c
1½" dia., 9 cyl. 50c

Aluminum Disc Rubber Tired Air Wheels
1" dia.....18c pr.
1¼" dia.....20c pr.
1½" dia.....25c pr.

Bal. Tire Alum. Disc
1¼" dia.....25c pr.
1¾" dia.....28c pr.
2" dia.....30c pr.

Bal. Tired Cel. Disc Wheel
1½" dia.....30c pr.
1¾" dia.....33c pr.
2" dia.....35c pr.

Celluloid Wheels		Balsa Wheels	
¾" dia.	8c pr.		6 pr.
1" dia.	10c pr.		8 pr.
1⅜" dia.	15c pr.		10 pr.
1⅞" dia.	20c pr.		15 pr.
3" dia.	40c pr.		40 pr.

Swivel Joint Fork and Axle
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⅝" dia..... 6c ea.
¾" dia..... 7c ea.
⅞" dia..... 8c ea.
1" dia..... 9c ea.
1¼" dia.....10c ea.
1¼" dia.....11c ea.

AXLES — Threaded—fitted with washers, bushings and nuts.

Length	½"	¾"	1¼"
2"-5"-6"	12c	10c	20c
7"-8"-9"	14c	12c	23c
10"-11"-12"	18c	15c	25c

PROPELLERS

Hawk Type 2-bladed		Hawk Type 3-bladed		Die Cast 2-bladed		Standard 3-bladed	
2¼"	25c	4"	35c	1½"	10c	1½"	15c
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4½"	35c	5"	50c	3¼"	20c	4"	30c
5"	35c	5⅝"	60c	4"	25c	4½"	40c
5⅝"	40c	6¼"	70c	4½"	25c	5"	45c
6¼"	40c	7"	80c	5"	30c	6"	60c
7"	55c	8"	90c	5½"	35c	7"	70c
8"	65c	9"	$1.00	6"	40c	8"	80c
9"	75c	10"	1.10	6½"	45c	9"	90c
10"	85c	11"	1.25	6⅝"	50c	10"	$1.00

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1½"	18	18	18
2"	20	20	20
3"	28	28	28

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Long	Plain End	Toggled End	
⅛"	⅝"	.25c	.30c
⅜"	⅞"	.30c	.35c
1"	1¼"	.30c	.35c
1½"	1¾"	.50c	55c

Dummy Turnbuckles
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⅜" .....10c each
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2" blade.....18c
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apartment on the field. However, an officer must feed and clothe himself, including uniforms.

AS A PERMANENT CAREER

For the past four years and a half only West Point graduates (who, of course, have completed the flying course) have filled the officer ranks of the regular Air Corps. Flying Cadet graduates were commissioned in the reserve, given a short tour of active duty and then placed on inactive status, that is, sent back home. No job, no pay.

Vacancies enough to commission permanently several hundred such ex-Flying Cadets were authorized by Congress, but Congress has not appropriated enough money to pay that many officers plus those in other branches of the army and the War Department has not turned over any vacancies to the Air Corps from the army as a whole (including the Air Corps) to be filled by ex-Flying Cadets.

No one knows when there will be any vacancies turned over to the Air Corps for the commissioning of ex-Flying Cadets. It's a sad fact, but no one with authority is doing or can do anything about it. Meanwhile the Air Corps is still about 300 or more officers understrength.

Nor is the Air Corps career any bed of roses for even the ex-West Pointers. The work? Wonderful, interesting, with dozens of specialties to pursue after the first few years in the Air Corps. Bombardment, pursuit, attack, observation or transport squadrons to fly in.

The schools—the Technical School with its interesting technical courses, the Engineering School where design is studied or the Tactical School where the fine points of air and air-ground tactics are taught—are open to him. Promotion, however, is slow.

The famous "Light Horse" Harry Wilson, former West Point football hero, has been six years a second lieutenant and has just been promoted to first lieutenant in the Air Corps. Officers who started flying training in 1918 are only captains by now. Pay is good enough but there are many expenses attached to a career as a flying officer.

THE AIR CORPS SOLDIER-MECHANIC

HAVING disposed of the student-pilot question, let us investigate that of the Air Corps soldier. This should interest those who intend to enlist in the Air Corps for the purpose of obtaining a high priority for appointment as Flying Cadet and be of even greater interest to the fellow who cannot pass either or both the physical or mental examination for Flying Cadet but who is healthy enough and not exactly a dumbbell and who likes to work around airplanes and their accessories.

To begin with, the composite picture of the Air Corps soldier shows a mighty fine sort of fellow, respected by his officers as he respects them, as being an able member of an able team. Air Corps officers on detached duties away from squadrons will remark, "I sure miss my soldiers." They are just as much a part of the Air Corps picture as the airplanes or the pilots.

Now, how can one become an enlisted member of this army flying team? The applicant for enlistment should apply to the nearest Army Recruiting Office. In the navy, one must enlist for general naval service and may then request transfer to the naval air service; but the army allows enlistment direct from civil life in to the Air Corps.

The applicant must be between the ages of 18 and 35 years, and if under 21 years, must have the written consent of his parents or guardian. He must be single and have no one dependent upon him for support. He must be of excellent character and reputation in the community in which he lives and must have letters from two reputable persons who can testify to his good character. He must be a citizen or have his first papers. He must be in sound physical condition.

Where there are more applicants for enlistment than there are vacancies there is a priority list of applicants established and the most desirable men are chosen for enlistment.

Master Sergeant Harry H. Hewitt, the Sergeant-Major or highest ranking soldier at the 1st Pursuit Group station at Selfridge Field, Michigan, looks over every recruit for that field very carefully. He tells me that he is getting the finest young men in the United States. The majority of them are high school graduates or have had good mechanical experience. Enlistment is for a period of three years.

The successful applicant is sent from the place he enlists to where he is needed at government expense. There he receives his uniforms and other clothing and takes his place in the squadron.

He finds the food excellent and the treatment fair and impartial. With the majority of army air fields enjoying new hangars, barracks, and other buildings there isn't as much unskilled labor not related to airplanes as there was several years ago. The recruit, therefore, stands a good chance to work in the hangars within a month after enlistment.

Some start in immediately, if they know a mechanical trade, but the hangar sergeant and the Engineers officer generally make sure that the recruit is trustworthy before giving him that privilege. Remember, one does not enlist as an airplane mechanic but as a soldier in the Air Corps, and his commanding officer will be the boss. He may put you on other jobs.

In a squadron of 132 men, the great majority are either non-coms (corporals or sergeants of various grades) or receive extra pay as specialists or air mechanics, or for flying. Privates ($21 a month) and privates first class ($30 a month) may be specialists with extra pay from $3 to $30 a month. Or privates to sergeants may be air mechanics, 2nd or 1st class, with full salary of $72 or $84 a month.

Or all grades of enlisted men may draw flying pay for being a member of an airplane crew—equal to 50 percent extra of their base pay. Therefore, the private of $21 a month is the exception rather than the rule in the Air Corps. Promotion is generally faster in squadrons in Hawaii, the Philippines or Panama and vacancies are often open for enlistment in those places.

Soldiers do considerable flying but they are *not* taught to pilot the airplane. That is one of the things that Master Sergeant Hewitt and his commanding officer, Major Ralph Royce make clear to all applicants for enlistment at Selfridge Field. However soldiers serve as aerial gunners, radio operators and mechanics, engine mechanics, crew chiefs or aerial photographers with duties that require their services in flight. In other words they may be part of a ship's flying crew.

Then there is the Air Corps Technical School at Chanute Field, Rantoul, Illinois. Selected men from the squadrons are always being sent there to take one of the dozen technical courses to fit them for the cream of the jobs in the squadron. They are generally flown there and back in army transport planes.

To sum up the life as an Air Corps soldier, it is not a bowl of gravy, although it offers lots of opportunities for the man who wants to get ahead and who likes airplanes and living with and working around them.

END

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